

KARNATAKUNIVERSITY, DHARWAD



Regulations and Syllabus

for

P.G. Studies in

**MASTER OF COMPUTER
APPLICATIONS**

(M.C.A.)

(I-IV Semester)



Revised Syllabus

Under

Choice Based Credit System (CBCS)

From

2020-21 onwards

**Regulations Governing Post-Graduate Programmes in the
Faculty of Science & Technology under Choice Based Credit System**
(Framed under Section 44(1)(c) Of the K.S.U.Act.2000)

1.0 Title

These Regulations shall be called “Regulations Governing the Post-Graduate Programmes in the Faculty of Science & Technology under Choice Based Credit System” in Karnatak University, Dharwad

2.0 Commencement

These Regulations shall come into force with effect from the academic year 2020-21.

3.0 Definitions

- a In these Regulations, unless otherwise provided;
“Academic Council” means Academic Council of the University constituted according to the *Karnataka State Universities Act, 2000*.
- b “Board of studies means P. G. Board of studies of the University, Adhoc/Combined and Steering Committees of International Diploma programmes in the discipline/subjects concerned.
- c “Compulsory Course” means fundamental paper, which the student admitted to a particular Post-Graduate Programme, should successfully complete to receive the Post Graduate Degree in the concerned subject.
- d Course Weightage “means number of credits assigned to a particular course.
- e “Credit” means the unit by which the course work is measured. One Credit means one hour of teaching work or two hours of practical work per week. As regard the marks for the courses, 1 Credit is equal to 25 marks, 2 credits are equal to 50 marks, 3 credits are equal to 75 marks and 4 credits are equal to 100 marks.
- f “Cumulative Grade Point Average(CGPA)”refers to the cumulative Grade Point Averages weighted across all the semesters and is carried forward from first semester to subsequent semesters.
- g “Degree” means Post-Graduate Degree.
- h “Grade” is an index to indicate the performance of a student in the selected course. These Grades are arrived at by converting marks scored in each course by the candidate in both Internal Assessment and Semester-end Examinations.
- i “Grade Point Average”(GPA)” refers to an indication of the performance of the student in a given semester.GPA is the weighted average of all Grades a student gets in a given semester.
- j “Open Elective Course “means a paper offered by a Department to the students of other Departments.
- k “Post Graduate Programme“ means semester wised Master’s Degree Programme’s excluding P. G. Diploma.
- l “Specialization course” means advanced paper offered by a Department that a student of that Department can opt a special course.

m “Student” means the student admitted to programmes under (k).

n “University “means Karnatak University, Dharwad.

4.0 Minimum Eligibility for Admission

A candidate who has successfully completed Bachelor’s Degree programme in Science or any other Degree programme of this University or of any other University recognized as equivalent there to by this university, shall be eligible for admission to the Post Graduate Programmes in science provided the candidate also satisfies the conditions like the minimum percentage of marks and other eligibility conditions as prescribed by the university from time to time and Government of Karnataka (Karnataka Examination Authority), Bangalore.

Admission shall be as per Government of Karnataka reservation policy and the directions issued in this regard from time to time.

5.0 Duration of the programme

The duration of the study for the Post-Graduate Degree programme shall extend over a period of two consecutive academic years, each academic year comprising two semesters, and each semester comprising sixteen weeks with a minimum of ninety working days.

However the student, who discontinue the programme after one or more semesters due to extraordinary circumstances, are allowed to continue and complete the programmer with due approval from the Registrar. Candidates shall no register for any other regular course other than diploma and certificate courses being offered on the campus during the duration of P.G. Programme.

6.0 Medium of Instruction and Evaluation

The medium of instruction shall be in English.

7.0 Programme Structure

7.1 The student of Post –Graduate programme shall study the courses as may be approved by the concerned Board of Studies, Faculty and the Academic Council of the University from time to time minimum and maximum credits as outlined in these regulations.

7.2 There shall be three categories of courses namely, compulsory courses, specialization Courses and Open Elective Courses.

7.3 Each programme shall have a set of compulsory courses, as stipulated in the regulations governing the concerned programme that a student must complete to get the concerned programme that a student must complete to get the concerned degree.

7.4 In those programmes that offer specialization courses, the student shall choose the prescribed number of specialization courses offered within the Department

7.5 Each Department shall offer Open Elective courses for students of other Departments, The students of a Department shall choose Open Elective courses from among those prescribed by the university and selected by the Department from time to time. P.G. Centers and affiliated colleges can offer those open Elective Course, which are approved or prescribed by their Parent Department of the University. Such open Elective courses shall be taught by qualified teachers approved by the University.

7.6 The credits for each of the Compulsory Courses may vary from 2 to 4; for Specialization Course, from 2 to 4; and for Open Elective Course, from 2 to 4, wherever project work/field work/practical are involved in the course, the credits may extend to 6 or as otherwise provided by concerned programme.

7.7 The minimum credits for P.G. Programme shall be 96. In the case of MCA, the minimum number of credits shall be 158 and in case of M Sc. Computer Science the minimum credits are 116.

- 7.8 The student shall undertake project/field work during the programme as a compulsory course or in lieu of Specialization Course or open Elective Course if so specified by the concerned Board of Studies.
- 7.9 The ratio between Compulsory, Specialization and Open Elective may differ from department to department.
- 7.10 The detailed programme structure for Faculty of Science & Technology shall be as prescribed and shown in Annexure-I, Annexure-IA, Annexure-Ib.
- 7.11 The Open Elective courses generally will have practical component, unless otherwise specified by the respective Board of Studies. The number of students admitted to the course shall commensurate with the availability of infrastructure.

8.0 Attendance

- 8.1 Each course shall be taken as a unit for the purpose of calculating the attendance.
- 8.2 Each student shall sign the attendance register maintained by the Department for each course for every hour/unit of teaching /practical. The course teachers shall submit the monthly attendance report to the Chairperson of the Department who shall notify the same on the notice board of the Department during the second week of the subsequent month.
- 8.3 Marks shall be awarded to the student for attendance as specified in the regulations concerning evaluation.
- 8.4 A student shall be considered to have satisfied the required attendance for each course if he/she has attended not less than 75% of the number of instructional hours during the semester.
- 8.5 There is no provision for condoning shortage of attendance.
- 8.6 The students who do not satisfy the prescribed requirement of attendance shall not be eligible for the ensuing examination. Such candidates may seek admission afresh to the given semester.
- 8.7 Such of the candidates who have participated in State/National level Sports, NSS, NCC, Cultural activities and other related activities as stipulated under the existing regulations shall be considered for giving attendance for actual number of days utilized in such activities (including travel days) subject to the production of certificates from the relevant authorities within two weeks after the event.

9.0 Examination

- 9.1 There shall be an examination at the end of each semester. The odd semester examinations shall be conducted by the respective Department/P.G. Centers/Colleges. The even semester examination shall be conducted by the University.
- 9.1.1 Unless otherwise provided, there shall be semester-end examination of 3 hours duration for 75/100 marks; 1.5 hours for 50 marks and 2/4 hours for 35/75 marks practical examination.
- 9.1.2 Every student shall register for each semester-end examination as per the University Notification by submitting duly completed application from through the proper channel and shall also pay the fees prescribed.
- 9.1.3 The office of the Registrar (Evaluation) shall allot the Register Number to the candidate at the 1st semester-end examination. That will be the Register Number to the candidate for all subsequent appearance at semester-end examinations.
- 9.1.4 The answer scripts shall be in the safe custody of the University for a maximum period of six months from the date of announcement of results. These shall be disposed off after six months.
- 9.1.5 The programme under CBCS is a fully carry-over system. A candidate reappearing for either the odd or even semester examinations shall be permitted to take examinations as and when they are conducted (even semester examination in even semester and odd semester examination in odd semester)

- 9.1.6** Candidate who have failed, remained absent or opted for improvement in any course/courses shall appear for such course/courses in the two immediate successive examinations that are conducted. However, in the case of the candidates appearing for improvement of their marks, the marks secured in the previous examination shall be retained, if the same is higher.
- 9.1.7** Candidates who desire to challenge the marks awarded to them, in the even semester-end examinations, may do so by submitting an application along with the prescribed fees to the Registrar (Evaluation) within 15 day from the announcement of results.

9.2 Odd Semester Examination

- 9.2.1** There shall be a Board of Examiners to set, scrutinise and approve question papers.
- 9.2.2** The BOE shall scrutinise and approve question papers submitted in two sets by the paper setters and submit the same to the office of the Registrar (Evaluation).
- 9.2.3** The office of the Registrar Evaluation shall dispatch the question papers to the Department/P.G.Center/Colleges who shall conduct the Examinations according to the Schedule announced by the University.
- 9.2.4** The Chairperson of the Department/Administrator of the P.G. Center/Principal of the College shall appoint one of their full time courses teachers as Post Graduate Programme (PGP) Coordinator who shall conduct the examinations and arrange for evaluation of answer scripts.
- 9.2.5** Answer scripts shall be valued by the examiners appointed by the University. However, in those centers where an examiner for a particular course is not available, then the answer scripts of that course shall be dispatched to the officer of the Registrar (Evaluation) who shall arrange for valuation of the same.
- 9.2.6** There shall be single valuation. The examiners (Internal or External) shall value the answer scripts and shall indicate the marks awarded to each question on the answer script.
- 9.2.7** The Marks List, a copy of the Examination Attendance Sheet and the sealed bundles of the answer scripts shall be dispatched by the PGP Coordinator to the Registrar (Evaluation)'s Officer at the conclusion of the valuation at the respective centers.
- 9.2.8** The Office of the Registrar Evaluation shall process and announce the results.

9.3 Even Semester

- 9.3.1** There shall be a Board of Examiners to set, scrutinise and approve question papers.
- 9.3.2** As far as practicable, it will be ensured that 50% of the paper setters and examiners are from other University/Research Institutes.
- 9.3.3** Each answer script of the semester-end examination (theory and project report) shall be assessed by two examiners (one internal and another external). The Marks awarded to that answer script shall be the average of these two evaluations. If the difference in marks between two evaluations exceeds 20% of the maximum marks, such a script shall be assessed by a third examiner. The marks allotted by the third examiner shall be averaged with nearer award of the two evaluations.
Provided that in case the number of answer scripts to be referred to the third examiner in a course exceeds minimum of 5 or 20% of the total number of scripts, at the even semester-end examinations, such answer scripts shall be valued by the Board of Examiners on the date to be notified by the Chairperson of the Board of Examiners and the marks awarded by the Board shall be final.
- 9.3.4** Wherever dissertation/project work is prescribed in the even semesters of the programme, the same shall be evaluated by both internal and external examiners. The valuation shall be as prescribed by the concerned Board of Studies.
- 9.3.5** In case of programmes with practical examination details of maximum marks, credits or duration may vary from Department to Department as specified by the concerned Board of Studies.

9.4 Evaluation

9.4.1 Each Course shall have two evaluation components – Internal Assessment (IA) and the Semester End Exams.

9.4.2 The IA component in a course shall carry 25% / 30% / 50% and the Semester End Examination shall carry 75% / 70% /50% respectively, as the case may be. Courses have 25% & 30%/50% marks as internal assessment shall have 3/5 marks allotted to attendance. However, in case of project work, the distribution of marks for Internal Assessment and Examination shall be left to the discretion of the concerned BOS.

9.4.3 Marks for attendance shall be awarded to the students according to the following table

For courses carrying 25% of marks for IA, the attendance marks shall be

Attendance (in Percentage)	Marks
Above 90	3
Above 80 and up to 90	2
Above 75 and up to 80	1

Internal Assessment (IA) shall be based on written tests, practical and seminars.

9.4.4 However, the number of IA components per course per semester shall not be less than two.

9.4.5 The IA marks list shall be notified on the Department Notice Board as and when the individual IA components are completed and the consolidated list shall be submitted to the Office of the Registrar Evaluation before the commencement of semester-end examination, or as directed by the University.

9.4.6 The test shall be written in a separately designated book supplied by the University which shall be open for inspection by the students after evaluation.

9.4.7 There is no provision for seeking improvement of Internal Assessment marks.

9.4.8 The IA records, pertaining to Semester Examination, shall be preserved by the department/Centers/Colleges for a period of one year from the date of semester examination. These records may be called by the University or a body constituted by the University as and when deemed necessary.

9.4.9 The dissertation/project work viva-voce shall be conducted by an internal and external examiner.

10.0 Maximum duration for completion of the Programme

10.1 A candidate admitted to a post graduate programme shall complete it within a period, which is double the duration of the programme from the date of admission.

10.2 Whenever the syllabus is revised, the candidate reappearing shall be allowed for the examinations only according to the new syllabus.

11.0. Declaration of Results

11.1 The minimum for a pass in each course shall be 40% of the total marks including both the IA and the semester-end examinations. Further, the candidate shall obtain at least 40% of the marks in the semester-end examination. There is no minimum for the IA marks.

11.2 Candidates shall secure a minimum of 50% in aggregate in all courses of a program in each semester to successfully complete the program.

11.3 Candidates shall earn the prescribed number of credits for the program to qualify for the PG Degree.

11.4 For the purpose of announcing the results, the aggregate of the marks secured by a candidate in all the semester examinations shall be taken into account. However, Ranks shall not be awarded in case the candidate has not successfully completed each of the semesters in first attempt or has not completed the program in the stipulated time (vide Regulation 5) or had applied for improvement of results.

12.0 Marks, Credit Points, Grade Points, Grades and Grade Point Average.

12.1 The grade points and the grade letters to candidates in each course shall be awarded as follows:

Percentage of marks	Grade Points	Grade Letter
75 and above, up to 100.00 %	7.50 to 10.00	A
60 and above but less than 75 %	6.00 and above but less than 07.5	B
50 and above but less than 60 %	5.00 and above but less than 6.0	C
40 and above but less than 50 %	4.00 and above but less than 05.00	D
less than 40.00 %	Less than 4.00	F

12.2 Credit Point (CP): The Credit Point for each course shall be calculated by multiplying the grade point obtained by the credit of the course.

12.3 The award of Grade Point Average (GPA) for any student is based on the performance in the whole semester. The student is awarded Grade Point Average for each semester based on the Total Credit Points obtained and the total number of credits opted for. The GPA is calculated by dividing the total credit points earned by the student in all the courses by the total number of credits of those courses of the semester.

12.4 The Cumulative Grade Point Average (CGPA) shall be calculated by dividing the total number of credit points in all the semesters by the total number of credits in all the semesters. The CGPA to date shall be calculated by dividing the total number of credit points in all the semesters to date by the total number of credits in all the semesters to date.

CGPA for the I Semester = Sum of the CP of the I Semester / Sum of the credits of the I Semester

CGPA for the II Semester = Sum of the CP of the I Semester + Sum of the CP of II Semester / Sum of the credits of the I Semester + II Semester

CGPA for the III and IV Semesters shall be computed accordingly.

12.5 The Grade Card at each semester examination shall indicate the courses opted by the student, the credit for the course chosen by the student, the credit points obtained in each course, the grade letter and the grade point average. No class shall be awarded for each semester and the same would only be awarded at the end of all the semesters based on Cumulative Grade Point Average.

12.6 Class shall be awarded to the successful candidates based on the Cumulative Grade Point Average (CGPA) as specified below:

Cumulative Grade Point Average (CGPA)	Class To Be Awarded
7.5 to 10.0	First Class With Distinction
6.0 and above but below 7.5	First Class
5.0 and above but below 6.0	Second Class

13. Miscellaneous:

- a.** Notwithstanding anything contained in these regulations, the semester system at Post-Graduate level is hereby repealed.
- b.** The provisions of any order, Rules or Regulations in force shall be inapplicable to the extent of its inconsistency with these Regulations.
- c.** The University shall issue such orders, instructions, procedures and prescribe such format as it may deem fit to implement the provisions of this Regulations.
- d.** The procedural details may be given by the University from time to time.
- e.** Any unforeseen problems/ difficulties may be resolved by the Vice Chancellor, whose decision in the matter shall be final.

Annexure-I

The Program structure of the Master of Science Degree shall be as follows:

Semester	No. of compulsory & Specialization courses (credits/course)	Total credits for compulsory & Specialization courses	No. of open elective course (credits/course)	Total credits of open elective course	Total credits for the semester
Sem. I	Th :03 (04) =12 Pra/Th*:03 (02)=06	18	Th :01 (04) =04 Pra/Th*:01(02)=02	06	24
Sem. II	Th :03 (04) =12 Pra/Th*:03 (02)=06	18	Th :01 (04) =04 Pra/Th*:01(02)=02	06	24
Sem. III	Th:03(04)=12 Pra/Th*:03 (02)=06	18	Th :01 (04) =04 Pra/Th*:01(02)=02	06	24
Sem. IV	Th :03/04** (04) =12/16 Pra/Th: 03/04***(02)=06/08 Pj [#] 01 (06) =06	24		-	24
Total	Th 12/13 (4) =48/52 Pra/Th 12/13(02)= 24/26 Pj: 1 (06)=06	78	03 (04)=12 Pra/Th*:03(02)=06	18	96

Note: Except for IV semester, the concerned Department shall offer one each of open elective theory and practical course or two * open elective Theory courses for students of other science departments. * Only for Mathematics; ** for Mathematics and Statistics; # except Mathematics & Statistics Abbreviations: Th = Theory; Pra = Practical; Pj = Project

GRADE CARD

Program: MCA (.....)

Name of the candidate: Semester:IV

Seat No: Month & Year:

Course	Course Code	Credit	IA Marks		Theory/ Practical		Max	Marks Obtained	Semester Grade Point	Credit Point
			Max	Obt	Max	Obt				
Compulsory Courses										
Course - I	XX CT 4.1	04	25	15	75	45	100	60	6.00	24.00
Course - II	XX CT 4.2	04	25	15	75	59	100	74	7.40	29.60
Course - III	XX CT 4.3	04	25	15	75	28	100	43	4.30	17.20
Course - IV	XX CP 4.4	02	15	06	35	34	50	40	8.00	16.00
Total		14					350			

XX refers to course abbreviations. 4.1 refers to IV semester course 1; e.g. CHI CT 1.1= Chemistry Inorganic compulsory theory 1.1

except for Mathematics and Statistics; * For Statistics and mathematics; +Only for Statistics; ^only for Mathematics

$$\text{GPA for IV Semester} = \frac{\text{CP (IV Sem)}}{\text{Credits (IV Sem)}} = \frac{200}{24.00} = 8.33$$

$$\text{GPA for I Semester} = \frac{\text{CP (I Sem)}}{\text{Credits (I Sem)}}$$

$$\text{CGPA for I Semester} = \text{GPA for I Semester CP (I Sem)} + \text{CP (IISem)}$$

$$\text{CGPA for II Semester} = \frac{\text{CP(I SEM)} + \text{CP(II SEM)}}{\text{Credit(I Sem)} + \text{Credit(II Sem)}}$$

$$\text{CGPA for III Semester} = \frac{\text{CP(I SEM)} + \text{CP(II SEM)} + \text{CP(III SEM)}}{\text{Credit(I Sem)} + \text{Credit(II Sem)} + \text{Credit(III Sem)}}$$

$$\text{CGPA for the program} = \frac{\text{CP(I SEM)} + \text{CP(II SEM)} + \text{CP(III SEM)} + \text{CP(IV Sem)}}{\text{Credit(I Sem)} + \text{Credit(II Sem)} + \text{Credit(III Sem)} + \text{Credit(IV Sem)}}$$

$$\text{CGPA for the program} = \frac{\text{CP(I SEM)} + \text{CP(II SEM)} + \text{CP(III SEM)} + \text{CP(IV Sem)}}{\text{Credit(I Sem)} + \text{Credit(II Sem)} + \text{Credit(III Sem)} + \text{Credit(IV Sem)}}$$

(*CP:Credit Points)

Annexure-1a

The program structure of the MCA shall be as follows:

Semester	No. of compulsory & Specialization courses (credits/course)	Total credits for compulsory & Specialization courses	No. of open elective course (credits/course)	Total credits of open Elective course	Total credits for the semester
Sem. I	Th :05 (04) =20Pra:01(04)=04	24	Th :01 (04) =04 Pra:01(02)=02	06	30
Sem. II	Th :05 (04) =20Pra:01(04)=04	24	Th :01 (04) =04 Pra:01(02)=02	06	30
Sem. III	Th :05 (04) =20Pra:01(04)=04	24	Th :01 (04) =04 Pra: 01(02)=02	06	30
Sem. IV	Th :05 (04) =20Pra:01(06)=06	26	-----	-----	26
Total	Th 20 (04) =80 Pra 03(04)=12 Pj :1 (06)=06	98	Th:03 (04)=12 Pra:03(02)=06	18	116

Note: Except for I and IV semester, the concerned Department shall offer one each of open elective theory and practical for students of other science departments.

Abbreviations: Th = Theory; Pra = Practical; Pj = Project;

GRADE CARD

Program: MCA

Name of the candidate:

Semester: I/II/III

Seat No:

Month & Year:

Courses	Course Code	Credit	IA Marks		Theory/ Practical		Max Marks	Marks Obtained	Semester Grade Point	Credit Point
			Max	Obt	Max	Obt				
Compulsory Courses										
Course - I	CT X.1	04	25	15	75	45	100	60	6.00	24.00
Course - II	CT X.2	04	25	15	75	59	100	74	7.40	29.60
Course - III	CT X.3	04	25	15	75	50	100	65	6.50	26.00
Course - IV	CT X.4	04	25	15	75	45	100	60	6.00	24.00
Course - V	CT X.5	04	25	15	75	50	100	65	6.50	26.00
Course - VI	CT X.6	04	25	15	75	45	100	60	6.00	24.00
Open elective courses:										
Course - VII	ET X.7	04	25	15	75	50	100	65	6.50	26.00
Course - VIII	ET X.8	02	10	05	40	35	50	40	8.00	16.00
Total		30					750			195.60

CT: Core Theory

CP: Core Practical

X:Semester

GRADE CARD

Program: MCA

Name of the candidate:

Semester:IV

Seat No:

Month & Year:

Course	Course Code	Credit	IA Marks		Viva-voce		Theory/ Practical		Max Marks	Marks Obtained	Semester Grade Point	Credit Point
			Max	Obt	Max	Obt	Max	Obt				
Compulsory Courses												
Course - I	CT 4.1	04	25	15			75	45	100	60	6.00	24.00
Course - II	CT 4.2	04	25	15			75	59	100	74	7.40	29.60
Course - III	CT 4.3	04	25	15			75	50	100	65	6.50	26.00
Course - IV	CPR 4.4	06	25	15	50	40	75	45	150	120	8.00	48.00
Course - V	CT 4.5	04	25	15			75	50	100	65	6.50	26.00
Course - VI	CT 4.6	04	25	15			75	45	100	60	6.00	24.00
Total		26							650			177.60

CT: Core Theory

CP: Core Project

CGPA for I Semester = $195.60/30=6.52$

CGPA for I Semester=GPA=6.52

CGPA for II Semester = $CP(I SEM)+CP(II SEM)$

$\frac{\text{Credit(I Sem)} + \text{Credit(II Sem)}}{\text{Credit(I Sem)} + \text{Credit(II Sem)}}$

CGPA for III Semester= $CP(I SEM)+CP(II SEM)+CP(III SEM)$

$\frac{\text{Credit(I Sem)} + \text{Credit(II Sem)} + \text{Credit(III Sem)}}{\text{Credit(I Sem)} + \text{Credit(II Sem)} + \text{Credit(III Sem)}}$

CGPA for the program = $CP(I SEM)+CP(II SEM)+CP(III SEM)+CP(IV Sem)$

$\frac{\text{Credit(I Sem)} + \text{Credit(II Sem)} + \text{Credit(III Sem)} + \text{Credit(IV Sem)}}{\text{Credit(I Sem)} + \text{Credit(II Sem)} + \text{Credit(III Sem)} + \text{Credit(IV Sem)}}$

(*CP:Credit Points)

Annexure-1b

The program structure of the **Master of Computer Applications (MCA)** shall be as follows:

Semester	No. of compulsory & Specialization courses (credits/course)	Total credits for compulsory & Specialization courses	No. of open elective course (credits/course)	Total credits of open elective course	Total credits for the semester
Sem.I	Th :05 (04) =20 Pra:01(04)=04	24	Th :01 (04) =04 Pra:01(02)=02	06	30
Sem.II	Th :05 (04) =20 Pra:01(04)=04	24	Th :01 (04) =04 Pra:01(02)=02	06	30
Sem.III	Th :05 (04) =20 Pra:01(04)=04	24	Th :01 (04) =04 Pra:01(02)=02	06	30
Sem.IV	Th :05 (04) =20 Pra:01(04)=04 SR:01(02)=02	26	-----	-----	26
Total	Th:20 (04) =80 Pra:05(04)=020 SR:02(02)=004 Pj:1 (16)=016	98	Th:03 (04)=12 Pra:03(02)=06	18	116

Note: Except for I and IV semester, the concerned Department shall offer one each of open elective theory and practical for students of other science departments.

Abbreviations: Th = Theory; Pra = Practical; Pj = Project;

GRADE CARD

Program: MCA

Name of the candidate:

Semester: I/II/III

Seat No:

Month & Year:

Courses	Course Code	Credit	IA Marks		Theory/ Practical		Max Marks	Marks Obtained	Semester Grade Point	Credit Point
			Max	Obt	Max	Obt				
Compulsory Courses										
Course - I	CT X.1	04	25	15	75	45	100	60	6.00	24.00
Course - II	CT X.2	04	25	15	75	59	100	74	7.40	29.60
Course - III	CT X.3	04	25	15	75	50	100	65	6.50	26.00
Course - IV	CT X.4	04	25	15	75	45	100	60	6.00	24.00
Course - V	CT X.5	04	25	15	75	50	100	65	6.50	26.00
Course - VI	CT X.6	04	25	15	75	45	100	60	6.00	24.00
Open elective courses:										
Course - VII	ET X.7	04	25	15	75	50	100	65	6.50	26.00
Course - VIII	ET X.8	02	10	05	40	35	50	40	8.00	16.00
Total		30					750			195.60

CT: Core Theory

CP: Core Practical

CSR: Core Seminar

X:Semester

GRADE CARD

Program: MCA

Name of the candidate:

Semester: IV

Seat No:

Month & Year:

Courses	Course Code	Credit	IA Marks		Theory/ Practical		Max Marks	Marks Obtained	Semester Grade Point	Credit Point
			Max	Obt	Max	Obt				
Compulsory Courses										
Course - I	CT X.1	04	25	15	75	45	100	60	6.00	24.00
Course - II	CT X.2	04	25	15	75	59	100	74	7.40	29.60
Course - III	CT X.3	04	25	15	75	50	100	65	6.50	26.00
Course - IV	CT X.4	04	25	15	75	45	100	60	6.00	24.00
Course - V	CT X.5	04	25	15	75	50	100	65	6.50	26.00
Course - VI	CP X.6	04	25	15	75	45	100	60	6.00	24.00
Course - VII	CSR X.7	02	---	---	---	---	50	40	8.00	16.00
Total		26					650			169.60

CT: Core Theory

CP: Core Practical

CSR: Core Seminar

X:Semester

Programme Outcomes (PO):

Programme Outcomes	
PO1	Apply knowledge of Computing fundamentals, Computing specialization, Mathematics, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.
PO2	Identify, formulate, and solve complex Computing problems reaching substantiated conclusions using fundamental principles of Mathematics, Computing sciences, and relevant domain disciplines.
PO3	Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration to societal, and environmental considerations.
PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO5	Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.
PO6	Understand and commit to professional ethics and information security, responsibilities, and norms of professional computing practice.
PO7	Recognize the need, and have the ability, to engage in independent learning for continual development as a Computing professional.
PO8	Demonstrate knowledge and understanding of computing and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO9	Communicate effectively with the computing community, and with society at large, about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.
PO10	Understand and assess societal, environmental, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.
PO11	Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary environments.
PO12	Identify a timely opportunity and using innovation to pursue that opportunity to create value and wealth for the betterment of the individual and society at large.

Programme Specific Outcome (PSO):

Program Specific Outcome (PSOs)	
PSO1	Gain the knowledge of computer programs/computer-based systems in the areas related to algorithms, networking, web design, database systems, data mining, artificial intelligence, IoT, Finite Automata and advanced java and operating system.
PSO2	Acquire professional skills and knowledge of software design and testing methods which will help to work as software engineer.
PSO3	Provide effective and efficient real time solutions using acquired knowledge in various domains.
PSO4	To make graduates understand cross cultural, societal, professional, legal and ethical issues prevailing in industry.
PSO5	Develop the ability to communicate ideas effectively.
PSO6	They will possess leadership and managerial skills with best professional ethical practices and social concern and will be able to communicate technical information effectively, both orally and in writing.
PSO7	Design and develop various application software projects to meet the demands of IT industry using modern software tools like php, java, net beans, .NET framework, mysql and spss.
PSO8	The subjects in the syllabus help the students to prepare for NET and KSET exams, so that they can join teaching profession or research work.
PSO9	The students can work on academic projects.

SEMESTER - I

Sem. No.	Paper Code	Paper Title	Credits	No. of Hrs/Week Theory/ Practical	Duration of exam In Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
I	MCA 1.1	Digital Logic and Computer Design	4	4	3	25	75	100
	MCA 1.2	Discrete Mathematical Structures	4	4	3	25	75	100
	MCA 1.3	Introduction to Algorithms	4	4	3	25	75	100
	MCA 1.4	Data structures using C	4	4	3	25	75	100
	MCA 1.5	Algorithms Lab	4	4	3	25	75	100
	MCA 1.6	Data structures Lab	4	4	3	25	75	100
		Total	24	24	18	150	450	600

SEMESTER - II

Sem. No.	Paper Code	Paper Title	Credits	No. of Hrs/Week Theory/ Practical	Duration of exam In Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
II	MCA 2.1	Probability and Statistics	4	4	3	25	75	100
	MCA 2.2	Computer Networks	4	4	3	25	75	100
	MCA 2.3	Python Programming	4	4	3	25	75	100
	MCA 2.4	Database Management System	4	4	3	25	75	100
	MCA 2.5	Python Programming Lab	4	4	3	25	75	100
	MCA 2.6	DBMS Lab (Using My SQL)	4	4	3	25	75	100
	Open Elective							
	OEC 2.7	Computer Concepts and Office Automation	4	4	3	25	75	100
		Total	28	28	21	175	525	700

SEMESTER - III

Sem. No.	Paper Code	Paper Title	Credits	No. of Hrs/Week Theory/ Practical	Duration of exam In Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
III	MCA 3.1	Design and Analysis of Algorithms	4	4	3	25	75	100
	MCA 3.2	Core Theory Electives-I	4	4	3	25	75	100
	MCA 3.3	Data Mining	4	4	3	25	75	100
	MCA 3.4	Web Technologies	4	4	3	25	75	100
	MCA 3.5	Data Mining Lab	4	4	3	25	75	100
	MCA 3.6	Web Technologies Lab	4	4	3	25	75	100
	Open Elective							
	OEC 3.7	SPSS Software	4	4	3	25	75	100
		Total	28	28	21	175	525	700

Core Theory Electives-I:

Subject Code	Elective Title
MCA 3.2 A	Linear Algebra
MCA 3.2 B	Operating System Concepts
MCA 3.2 C	Computer Graphics
MCA 3.2 D	Mobile Computing
MCA 3.2 E	Cloud Computing
MCA 3.2 F	Business Intelligence Systems

SEMESTER –IV

Sem. No.	Paper Code	Paper Title	Credits	No. of Hrs/Week Theory/ Practical	Duration of exam In Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
IV	MCA 4.1	Software Engineering	4	4	3	25	75	100
	MCA 4.2	Core Theory Electives-II	4	4	3	25	75	100
	MCA 4.3	Artificial Intelligence and Machine Learning	4	4	3	25	75	100
	MCA 4.4	Operation Research	4	4	3	25	75	100
	MCA 4.5	Project	4	4	3	25	75	100
	MCA 4.6	Artificial Intelligence and Machine Learning Lab	4	4	3	25	75	100
		Total	24	24	18	150	450	600

Core Theory Electives-II:

Subject Code	Elective Title
MCA 4.2 A	Computer Vision
MCA 4.2 B	Internet of Things (IoT)
MCA 4.2 C	Mobile Communications
MCA 4.2 D	Deep learning
MCA 4.2 E	Information Security and Cryptography
MCA 4.2 F	Soft Computing

KARNATAK UNIVERSITY, DHARWAD

Department of Computer Science

Programme outcomes, Programme Specific Outcomes and Course Outcomes.

Master of Computer Application (MCA)

Programme Outcomes (PO):

Programme Outcomes	
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PSO9	The students can work on academic projects.

MCA 1.1: Digital Logic and Computer Design

Total Hours: 48

Course Outcome

Course Code: MCA 1.1 **Course Name:** Digital Logic and Computer Design

Upon Completion of the course, the students will be able to

- Introduce the concept of digital and binary systems.
- To design and analyze combinational logic circuits.
- To design and analyze sequential logic circuits.
- To learn the system design and memory organization

Unit-I

10 Hrs

Number Systems: binary, octal hexadecimal, number base conversion, addition, subtraction of binary numbers, one's and two's complements, positive and negative numbers, character codes ASCH, EBCDIC.

Boolean algebra and Logic gates: Axiomatic definition of Boolean algebra, Basic theorems and properties, Boolean functions, canonical and standard forms, logic functions using gates and design of combinational circuits.

Unit-II

10 Hrs

Simplification of Boolean functions: Karnaugh maps, product of sums, sum of products, simplification, NAND and NOR implementation, don't care condition.

Combinational and Sequential logic: Adders, subtractors, code, converters, decoder multiplexer, flip-flops, shift registers, counters.

Unit-III

10 Hrs

Processor Logic Design: Processor organization, arithmetic logic unit, design of arithmetic and logic circuits, design of arithmetic logic unit, status registers, design of shifter, processor unit, design of accumulator.

Control Logic Design: Processor Organization, Hardware control micro program control, control of processor unit, PLA control, micro program sequencer, computer design.

Unit-IV

10 Hrs

Micro – computer System Design: Microcomputer organization, microprocessor organization, instructions and addressing modes, subroutines and interrupts, memory organization, input-output interface, programmed input-output, input – output processor, input – output device characteristics, direct memory access (DMA).

Unit-V**8 Hrs**

Memory Organization: Serial access, random access memories (RAM), read only memories (ROM), virtual memory, cache memory.

Introduction to 8085 Assembly Language Programming: The 8085 Programming model, Instruction classification, Instruction format, How to write, Assemble and Execute a simple program, Overview of the 8085 Instruction set.

References:

1. Digital Logic and Computer Design, Morris Mano, PHI
2. Digital Computer Fundamentals, Bartee, T.C., MC Graw Hill
3. Computer Architecture and Organization, Tanenbaum A.S., Mc Graw Hill
4. Computer Architecture and Organization, hayes, J.P., Mc Graw Hill
5. Introduction to Microprocessors, Gaonkar, Tata Mc Graw Hill
6. Digital Computer Electronics Malvino & Brown Shird Education, TMH.

MCA 1.2: Discrete Mathematical Structures

Course Outcome

Upon Completion of the course, the students will be able to

- Comprehend and evaluate mathematical arguments revolving around computation.
- Understand the basics of Combinations and Permutations.
- Understand the basics of Graphs and Trees to real world applications.
- Represent relations matrices and digraphs.

Total Hours : 48

Unit-I

10Hrs

The Foundations: Logic and Proofs: Propositional Logic, Applications of Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Introduction to Proofs, Proof Methods and Strategy

Unit-II

10Hrs

Basic Structures: Sets, Functions, Sequences, Sums, and Matrices: Sets, Set Operations, Functions, Sequences and Summations, Matrices.

Unit-III

10Hrs

Induction and Recursion: Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions and Structural Induction, Recursive Algorithms, Program Correctness.

Advanced Counting Techniques: Applications of Recurrence Relations, Solving Linear Recurrence, Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion-Exclusion, Applications of Inclusion-Exclusion.

Unit-IV

08 Hrs

Relations : Relations and Their Properties, n-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings.

Unit-V

10 Hrs

Graphs: Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring.

Trees: Introduction to Trees, Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees.

Reference Book:

1. Discrete Mathematics and Its Applications, Kenneth H. Rosen: Seventh Edition, 2012.

2. Discrete Mathematical Structure, Bernard Kolman, Robert C. Busby, Sharon Ross, 2003.
3. Graph Theory with Applications to Engg & Comp. Sci.: Narsingh Deo-PHI 1986
4. Discrete and Combinatorial Mathematics Ralph P. Grimaldi, B. V. Ramana, Pearson, Education, 5 Edition
5. Discrete Mathematical Structures. Trembley and Manohar.

MCA 1.3: Introduction to Algorithms

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Understand the difference between program and algorithms.
- Learn how to write the algorithms.
- Understand the importance of algorithms.

Unit-I:

10 hrs

Introduction to Computer Problem Solving

Introduction, The Problem-solving Aspect, Top- down Design, Implementation of Algorithms, Program Verification, The Efficiency of Algorithms, The Analysis of Algorithms.

Fundamental Algorithms

Introduction, Exchange of Values of Two Variables, Counting, Summation of a Set of Numbers, Factorial Computation, Sine Function Computation, Generation of the Fibonacci sequence, Reversing the Digits of an Integer, Base Conversion, Character to Number Conversion

Unit-II:

10hrs

Factoring Methods

Introduction, Finding the Square Root of a Number, The Smallest Division of an Integer, The Greatest Common Divisor of Two Integers, Generating Prime Numbers, Computing the Prime Factors of an Integer, Generation of Pseudo-random Numbers, Raising a Number to a large Power, Computing the n th Fibonacci number

Unit-III:

10hrs

Array Techniques

Introduction, Array Order Reversal, Array Counting or Histogram Ming, Finding the Maximum Number in a Set, Removal of Duplicates from an Ordered Array, Partitioning an Array, Finding the k th Smallest Element, Longest Monotone Subsequence

Unit-IV:

10hrs

Merging, Sorting and Searching

Introduction, the Two-way Merge, Sorting by Selection, Sorting by Exchange, Sorting by Insertion, Sorting by Diminishing Increment, Sorting by Partitioning, Binary Search.

Unit-V:

08 hrs

Dynamic Data Structure Algorithms

Introduction, Stack Operations, Queue Addition and Deletion, Linked List Search, Linked List Insertion and Deletion, Binary Tree Search, Binary Tree Insertion and Deletion.

Recursive Algorithms

Introduction, Binary Tree Traversal, Recursive Quick sort, Towers of Hanoi Problem, Sample Generation, Combination Generation, Permutation Generation.

Reference:

1. How To Solve It By Computer by R. G. Dromey, Fifteenth Ed 2014
2. Algorithms and Data Structures: N. Wirth 1985 Oberon version: August 2004.
3. Algorithmic graph theory by Alan Gibbons, Cambridge University Press.
4. Introduction to Algorithms, by T. Cormen , C. Leiserson , R. Rivest , C Stein, 3Ed. International Edition, MIT Press,2009.
5. Graph Theory : Modeling, Applications and Algorithms by Geir Agnarsson,1st Edition,2008.

MCA 1.4: Data Structures using C

Total hours :48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Learn to analyze algorithms and algorithm correctness.
- Learn to summarize searching and sorting techniques.
- Learn to describe stack, queue and linked list operation.
- Learn to have knowledge of tree and graphs concepts.

Unit- I INTRODUCTION TO DATA STRUCTURES

08Hrs

Basic concepts: Introduction to data structures, classification of data structures, operations on datastructures; Searching techniques: Linear search and Binary search; Sorting techniques: Bubble sort,selection sort, insertion sort and comparison of sorting techniques.

Unit II - II LINEAR DATA STRUCTURES

10 Hrs

Stacks: Primitive operations, implementation of stacks using Arrays, applications of stacks, arithmeticexpression conversion and evaluation; Queues: Primitive operations; Implementation of queues usingArrays, applications of linear queue, circular queue and double ended queue (deque).

Unit - III LINKED LISTS

12 Hrs

Linked lists: Introduction, singly linked list, representation of a linked list in memory,Types of linked lists: Single linked listsCircular linked lists, doubly linked lists; operations on a single linked list; Applications of linked lists: Polynomial representation and sparse matrix manipulation.

Unit - IV NON LINEAR DATA STRUCTURES

10 Hrs

Trees: Basic concept, binary tree, binary tree representation, array and linked representations, binary tree traversal, binary tree variants, application of trees; Graphs: Basic concept, graph terminology, graph implementation, graph traversals, Application of graphs, Priority Queue.

Unit - V Binary search tree and HASHING

08 Hrs

Binary search trees, properties and operations; Balanced search trees: AVL trees; Introduction to M-Way search trees, B trees; Hashing and collision: Introduction, hash tables, hash functions, collisions, applications of hashing.

References:

1. S. Lipschutz, "Data Structures", Tata McGraw Hill Education, 1st Edition,2008.
2. D. Samanta, "Classic Data Structures", PHI Learning, 2nd Edition,2004.

Web References:

1. https://www.tutorialspoint.com/data_structures_algorithms/algorithms_basics.htm
2. <https://www.codechef.com/certification/data-structures-and-algorithms/prepare>
3. <https://www.cs.auckland.ac.nz/software/AlgAnim/dsToC.html>
<https://online-learning.harvard.edu/course/data-structures-and-algorithms>

MCA 2.1: PROBABILITY AND STATISTICS

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Understanding the basic probability axioms and rules.
- Understanding to derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions.
- Understanding to translate real-world problems into probability models.
- Understanding to calculate probabilities of absorption and expected hitting times for discrete time Markov chains.

Unit I: 8hrs.

Probability : Sample space and Events - Probability -The Axioms of probability - some Elementary Theorems - Conditional probability -Baye's Theorem - Random variables – Discrete and continuous probability distributions.

Unit II: 10hrs.

Distributions Binomial, Poisson and normal Distributions, related properties. Sampling Distributions – Sampling Distribution of means.

UNIT III: 8 hrs.

Estimation Point Estimation - Interval Estimation – Introduction to student's t-distribution - Confidence interval for Single Mean and Single Proportion (Large and Small samples).

Unit IV: 14hrs.

Testing of Hypothesis-I : Testing of hypothesis-Introduction- Null hypothesis- Alternative hypothesis- Type I and Type II errors – Critical region. Test of hypotheses for Single Mean (Large and small samples) - Test of hypotheses for Single Proportion (Large and small samples). **Testing of Hypothesis-II**: Tests of hypotheses for difference of Means (Large and Small samples) - Tests of hypotheses for difference of proportions(Large samples) – Introduction to Chi-Square distribution and Goodness of Fit.

Unit V: 8hrs.

Correlation & Regression: Coefficient of correlation- Regression Coefficient- The lines of regression- The rank correlation.

References

1. Probability & Statistics, T.K.V.Iyengar, B. Krishna Gandhi & Others,3ed,S.Chand & Co,2011
2. Probability & Statistics, D. K. Murugesan, P. Guru Swamy, 1ed, Anuradha Publications,2011

3. Probability & Statistics for Engineers, G.S.S. Bhishma Rao, 2ed, Scitech Publications, 2005
4. Probability & Statistics for Engineers, Miller, John E. Freund, 8ed, Prentice Hall of India, 2010
5. A first course in Probability & Statistics, B.L.S. Prakasa Rao, 1ed, World Scientific, 2010
6. Fundamentals of Mathematical Statistics, S.C. Gupta, V.K. Kapoor, 11 ed, S. Chand & Co., 2003

MCA 2.2: COMPUTER NETWORKS

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Understanding the network protocols.
- Understanding the network architecture and its components.
- To learn the different encoding and decoding mechanisms involved in different types of transmission media and to measure the transmission impairments.
- Understand different wireless and mobile networks concepts.

UNIT-I:

10hrs

Foundation- Building a Network, Applications, Requirements, Architecture, Software, Performance.

Direct Links- Connecting to a Network, Technology Landscape, Encoding, Framing, Error Detection, Reliable Transmission, Multi-Access Networks

UNIT-II:

10hrs

Internetworking: Switching Basics, Switched Ethernet, Spanning Tree Algorithm, Broadcast and Multicast, Virtual LANs (VLANs), What Is an Internetwork? Service Model, Global Addresses, Datagram Forwarding in IP, Subnetting and Classless Addressing, Address Translation (ARP), Host Configuration (DHCP), Error Reporting (ICMP), Virtual Networks and Tunnels, Routing- Network as a Graph, Distance-Vector (RIP), Link State (OSPF), Metrics

UNIT-III:

10hrs

Global Internet- Routing Areas, Inter-domain Routing (BGP)

IP Version 6- Historical Perspective, Addresses and Routing, Packet Format, Advanced Capabilities

Multicast- Multicast Addresses, Multicast Routing (DVMRP, PIM, MSDP)

Multiprotocol Label Switching- Destination-Based Forwarding, Explicit Routing, Virtual Private Networks and Tunnels

UNIT-IV:

10hrs

Simple Demultiplexor (UDP)

Reliable Byte Stream (TCP)- End-to-End Issues, Segment Format, Connection Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission

Remote Procedure Call- RPC Fundamentals

Transport for Real-Time (RTP)- Requirements, RTP Design, Control Protocol

Congestion Control- TCP Congestion Control

UNIT-V:**08hrs**

Applications-Traditional Applications- Electronic Mail (SMTP, MIME, IMAP), World Wide Web (HTTP), Web Services

Multimedia Applications- Session Control and Call Control (SDP, SIP, H.323), Resource Allocation for Multimedia Applications

Reference books:

1. Larry Peterson, "Computer Networks- A system approach", 5th edition, Elsevier
2. Kurose and Rose, "Computer Networking- A top down approach", 6th edition, Pearson, 2013
3. Andrew Tanenbaum, "Computer Networks", Prentice Hall
4. Behrouz Forouzan, "Data Communications and Networking", 4th edition, McGraw Hill, 2017

MCA 2.3: PYTHON PROGRAMMING

Total 48hrs.

Course Outcomes:

Upon Completion of the course, the students will be able to

1. Acquire programming skills in core Python.
2. Acquire Object Oriented Skills in Python
3. Develop the skill of designing Graphical user Interfaces in Python
4. Develop the ability to write database applications in Python

Unit-I

12hrs.

INTRODUCTION TO PYTHON PROGRAMMING: Python interpreter and interactive mode; values and types variables, expressions, statements, tuple assignment, Order of operations, comments, debugging; modules and functions: function Calls, adding new functions, Definitions and Uses, flow of execution, parameters and arguments, Fruitful functions. Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, range, break, continue, pass; recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays.

Unit-II

12hrs.

LISTS, TUPLES, DICTIONARIES: Lists: Traversing a List, list operations, list slices, list methods, Map, Filter and Reduce, list loop, mutability, aliasing, cloning lists, list parameters; Dictionaries: operations and methods; advanced list processing - list comprehension; Tuples: tuple assignment, tuple as return value.

Unit-III

07hrs.

FILES, MODULES, PACKAGES: Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages: PANDAS, NUMPY, SCIKIT-LEARN;

Unit-IV

10hrs.

CLASSES AND OBJECTS: Introduction, Defining Classes, Creating Objects, Data Abstraction and Hiding through Classes, Class method and self argument, Class Constructor (init() Method), Data Members, Calling a Class Method from another Class Method, Class Methods and Static Methods, Inheritance, Types of Inheritance, Abstract Classes and Interfaces, Operator Overloading, Overriding Methods.

Unit-V

07hrs.

Multithreading, GUI Programming, Graphics, Plotting and Web Programming: Multithreading-Introduction, Threading Module (Creating a Thread, Synchronizing Threads) GUI Programming with tkinter Package, Simple Graphics using Turtle, Plotting Graphs in Python, Web Programming using Python.

REFERENCES:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist,,,,, 2nd edition, Updated for Python 3, Shroff/O.,Reilly Publishers, 2016
2. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

3. John V Guttag, —Introduction to Computation and Programming Using Python,,,,, Revised and expanded Edition, MIT Press , 2013
4. Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

MCA 2.4: DATABASE MANAGEMENT SYSTEM

Total hours: 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Analyze the asymptotic performance of algorithms.
- Apply important algorithmic design paradigms and methods of analysis.
- Ability to analyze the performance of *algorithms*.
- Ability to choose appropriate *algorithm* design techniques for solving problems.

UNIT-I INTRODUCTION TO DBMS

10Hrs

Introduction, characteristics of database, advantages of DBMS over file processing system, A Brief History of Database Applications. Database softwares (microsoft SQL server, oracle RDBMS, MySQL) Data Models, Schemas, and Instances; Three-Schema Architecture and Data Independence; Database Languages and Interfaces; Centralized and Client/Server Architectures for DBMS.

UNIT-II DATA MODELING

10 Hrs

Entity-Relationship Diagram, Relational Model - Constraints, Languages, Design, and Programming, Relational Database Schemas, Update Operations and Dealing with Constraint Violations; Relational Algebra and Relational Calculus; Codd Rules.

Unit-III: Enhanced Data Models

12 Hrs

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.

UNIT-IV SQL AND NOSQL

08 Hrs

Data Definition and Data Types; Constraints, Queries, Insert, Delete, and Update Statements; Views, Stored Procedures and Functions; Database Triggers, SQL Injection. NOSQL: NOSQL and Query Optimization; Different NOSQL Products, Querying and Managing NOSQL; Indexing and Ordering Data Sets; NOSQL in Cloud.

UNIT -V NORMALIZATION FOR RELATIONAL DATABASES

08 Hrs

Functional Dependencies and Normalization; Algorithms for Query Processing and Optimization; Transaction Processing, Concurrency Control Techniques, Database Recovery Techniques, Object and Object-Relational Databases; Database Security and Authorization.

References:

1. "Database System Concepts" by Silberschatz, Korth, Sudarshan, 4th Edition, McGraw Hill Publication.
2. "Database Systems, Concepts, Design and Applications" by S.K.Singh, Pearson Education.
3. "Database Management Systems" by Raghu Ramakrishnan, Johannes Gehrke, McGraw Hill Publication.

4. “Fundamentals of Database Systems” by Elmsari, Navathe, 5th Edition, Pearson Education (2008).

MCA OEC 2.7: Computer Concepts and Office Automation

Total Hours: 48

Upon Completion of the course, the students will be able to

- Understand different Computer Peripherals.
- Understand and apply different Software components.
- Learn about Microsoft office software and its applications.

Unit-I

10 Hrs

Basics: History and generations of Computer, Types of Computer, Organization of Computer System, Hardware and Software Components, Memory unit: Types of memory, ROM, RAM, types of RAM & ROM, Introduction to cache and virtual memory.

Unit-II

10 Hrs

Number system: Binary Octal, Hexa-decimal, Number base conversion, Binary addition, Subtraction, One's and Two's compliment, Character codes – ASCII, EBCDIC.

Unit-III

10 Hrs

Operating System: Types of operating system, Functions, Introduction to DOS and WINDOWS operating system.

Software: Types of languages, Types of software (System and Application software).

Unit-IV

10 Hrs

Network and Internet: History and evolution of Computer Network, Types of network (LAN, MAN & WAN), Internet and its applications.

Unit-V

08 Hrs

Office Automation: Working with MS-Word, MS-Excel and MS-POWER POINT

Reference:

1. Computer Concepts & C Programming, P.B.Kottur, Sapna Book House Bangalore 2009
2. Computer Fundamentals, V. Rajaraman, Prentice Hall of India, 2008
3. Computer Fundamental P.K. Sinha, Prentice Hall of India, 6th Edition, 1992
4. Fundamentals of Information Technology second edition, Alexis Leon, 2009
5. Microsoft Office-Complete reference, Curt Simmons, Mc Graw Hill, 2003

MCA 3.1: Design and Analysis of Algorithms

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Analyze the asymptotic performance of algorithms.
- Apply important algorithmic design paradigms and methods of analysis.
- Ability to analyze the performance of *algorithms*.
- Ability to choose appropriate *algorithm* design techniques for solving problems.

Unit-I:

12 hrs

Introduction: What is an algorithm?, Fundamentals of Algorithmic Problem Solving, Important Problem Types, Fundamental data Structures.

Fundamentals of the Analysis of Algorithm Efficiency: Analysis Framework, Asymptotic Notations and Basic efficiency classes, Mathematical analysis of Recursive and Non-recursive algorithms.

Brute Force and Exhaustive Search: Selection Sort and Bubble Sort, Sequential Search and Brute-Force String Matching, Depth-First Search and Breadth-First Search

Unit-II:

8 hrs

Decrease-and-Conquer

Insertion Sort, Topological sorting, Algorithms for Generating Combinatorial Objects, Binary Search.

Divide-and-Conquer

Merge sort, Quick sort, Binary tree Traversals and related properties, Multiplication of large integers, Strassen's Matrix Multiplication

Unit-III:

10 hrs

Space and Time Tradeoffs

Sorting by Counting, Input Enhancement in String Matching, Hashing.

Unit-IV:

10 hrs

Dynamic Programming

Computing a binomial coefficient, Warshall's and Floyd's Algorithms, The Knapsack Problem and Memory Functions.

Unit-V:

08 hrs

Greedy Technique Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm.

Limitations of Algorithm Power

Lower-Bound Arguments, Decision Trees, P, NP and NP-Complete Problems.

Reference Books:

1. Introduction to the Design and Analysis of Algorithms, 3rd Edition, by Anany Levitin, Pearson, 2012,

2. Introduction to Algorithms, , 3Ed, by T. Cormen , C. Leiserson , R. Rivest , C Stein. International Edition, MIT Press, 2009.
3. Fundamentals of Computer Algorithms, *Ellis Horowitz; Sartaj Sahni; Sanguthevar Rajasekaran, Universitypress, 2008.*
4. Algorithm Design, Michael T Goodrich and Roberto Tamassia, Wiley India.
5. Introduction to Design and Analysis of Algorithms “R C T Lee, S S Tseng, R C, Chang, Y T Tsai, A Strategic Approach, Tata McGraw Hill.

MCA 3.3: Data Mining

Total Hours: 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Data preprocessing and data quality.
- Modeling and designing of data warehouses.
- apply Algorithms for data mining.
- Ability to apply acquired knowledge for understanding data and select suitable methods for data analysis.

Unit-I

10 Hrs

Data mining – Motivation – Importance - DM Vs KDD - DM Architecture - Data Types – DM Tasks –DM System Classification - Primitives of DM - Data Mining Query Language - DM Metrics - DM Applications - DM Issues – Social Implications of DM

Unit-II

10 Hrs

Data Preprocessing: Summarization - Data cleaning - Data Integration and Transformation - Data Reduction - Discretization and Concept Hierarchy Generation

Unit-III

10 Hrs

Mining Frequent Patterns – Frequent Item set Mining Methods. Classification: Classification by Decision Tree Induction – Bayesian Classification – Rule based Classification - Prediction– Accuracy and Error Measures

Unit-IV

10 Hrs

Cluster Analysis – Types of Data in Cluster Analysis – Categorization of clustering Methods – Partition Methods - Outlier Analysis – Mining Data Streams – Social Network Analysis – Mining the World Wide Web

Unit-V

8 Hrs

Data Warehousing: OLTP Vs OLAP - Multidimensional Data Model -DW Architecture Efficient Processing of OLAP queries - Metadata repository – DWH Implementation – OLAM

References:

1. JiaweiHan, Micheline amber, "Data Mining: Concepts and Techniques", 3rd Edition, Elsevier India Private Limited, 2012.
2. Margaret H. Dunham, "Data Mining: Introductory and Advanced Topics", Pearson Education, 2012.
3. K.P.Soman, ShyamDiwakar, V.Ajay, "Insight into Data Mining Theory & Practice, Prentice
4. Hall India, 2012 5. G.H.Gupta, "Introduction to Data Mining with Case Studies", 2nd Edition, PHI.
5. Ralph Kimball, Margy Ross "The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling", 3rd Edition ,wiley, Jul 2013

MCA 3.4: WEB TECHNOLOGIES

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Students are able to develop a dynamic webpage by the use of java script and DHTML.
- Students will be able to write a well formed / valid XML document.
- Students will be able to connect a java program to a DBMS and perform insert, update and delete operations on DBMS table.
- Students will be able to write a server side java application called Servlet to catchform data sent from client, process it and store it on database.
- Students will be able to write a server side java application called JSP to catch formdata sent from client and store it on database.

Unit-I:

10 hrs

Web essentials – W3C - clients – servers - communication – markup languages – XHTML – simple XHTML pages style sheets – CSS

Unit-II:

12 hrs

Client side programming: Introduction to Java script, Basic Syntax, Variables and Data types, Statements, Operators, Literals, Functions, Objects, Arrays, Built-in objects, Java script debuggers.

Host objects Browsers and the DOM: Introduction to Document Object Model, DOM history and levels, Intrinsic Event Handling, Modifying Element Style, The Document tree, DOM Event handling.

Unit-III:

12 hrs

Server side programming: (Java servlets) - Servlet Architecture Overview, A “Hello World!” Servlet, Servlet Generating Dynamic Content, Servlet lifecycle, Parameter Data, Sessions, Cookies, URL Rewriting, Other Servlet capabilities, Data Storage, Servlets and Concurrency.

Separating Programming and Presentation (JSP Technology): Introduction to Java Server Pages, JSP and Servlets, Running JSP Applications, Basic JSP, Java Beans Classes and JSP, Tag Libraries and Files, Support for the Model – View Controller Paradigm.

Unit-IV:

07 hrs

Representing Web Data: XML, XML document and Vocabularies, XML Declaration, XML Namespaces, Java Script and XML: Ajax, DOM based XML processing, Event-oriented Parsing: SAX, Transforming XML Documents, Selecting XML Data: XPath Template-based Transformation: XSLT, Displaying XML Documents in browsers.

Unit-V:

07 hrs

Web Services: JAX-RPC, WSDL, XML Schema and SOAP: Web Service Concepts, Writing a Java Web Service, Writing a Java Web Service Client, Describing Web Services: WSDL, Representing Data Types: XML Schema, Communicating Object Data: SOAP.

Databases and Java Servlets, Databases and JSP

References

1. Jeffrey C Jackson, “Web Technology – A computer Science perspective”, Person Education, 2007.
2. Chris Bates, “Web Programming – Building Internet Applications”, “Wiley India, 2006.

MCA OEC 3.7: SPSS Software

Total Hours: 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Understand how to start SPSS.
- Define a variety of statistical variables.
- Enter basic data into SPSS and carry out a statistical analysis that can test hypotheses.

UNIT-I

10Hrs

Table of Contents: Overview of PASW Statistics, Introduction to PASW: Menus, Tool Bar, Dialogue Box, Designate Window, Basic Steps for performing any Statistical Procedure

Data Management: Creating a Data File, Defining Variables, Entering the Data, Saving Data, Opening an existing Data File, Inserting Variables, Inserting Cases, Identifying Duplicate Cases, Identifying Unusual Cases, Sorting Cases, Merging a File: Add Cases, For Adding Variables, Data Aggregation, Splitting File, Selecting Cases, Listing Cases

UNIT-II

10Hrs

Data Transformation: Computing a New Variable, Recoding Variables, Automatic Recode, Visual Binning, Rank Cases

Describing Data Numerically: Types of Measurement Scales, Summary Measures, Frequencies, Descriptive Statistics, Explore, Crosstabs

UNIT-III

10Hrs

Describing Data Graphically: Line Chart, Pie Chart, Bar Chart, Histogram and the Standard Normal Curve, Box Plot, Scatter Diagram, P-P Plot, Q-Q Plot, Chart Builder, Formatting Charts

UNIT-IV

10Hrs

One Sample t-Test : Hypothesis Testing, Steps in Hypothesis Testing, Assumptions of Hypothesis Testing, Testing for Population Mean, Statistical and Practical Significance

Independent Sample t-Test: Assumptions of Independent Sample t-Test, Procedure for Testing for Differences in Means between Groups, Interpretation of Null Results, Effect Size

UNIT-V

08Hrs

Nonparametric Statistics: Runs Test, Chi-Square Test, Mann-Whitney U Test, Wilcoxon Signed Rank Test, Kruskal-Wallis Test

References

1. SPSS In Simple Steps by Kiran Pandya Smruti Bulsari Sanjay Sinha, Dreamtech Press (2011)

2. Applied Statistics with SPSS by Eelko Huizingh, New ed Edition, Sage Publications (CA) (2007)
3. SPSS: A User-Friendly Approach by Jeffery E. Aspelmeier, Thomas W. Pierce, Worth Publishers (2009)
4. Statistical Methods For Practice And Research : A Guide To Data Analysis Using SPSS 0002 Edition, Response Books (2009)
5. A Visual Approach to SPSS for Windows: A Guide to SPSS 17.0, by Leonard D. Stern, Pearson (2009)

MCA 4.1:Software Engineering

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Learn the phases of software development.
- Develop process models and process system models.
- Gather, understand, analyze and specify requirements.
- Develop architectural diagram, and implement by following coding principles.
- Apply testing strategies and handle software product maintenance issues.

Unit-I

10 Hrs

The Product and The Process: Evolving role of software, software characteristics and components, Crisis, Software Myths, Software Engineering-A Layered Technology, Software process, linear sequential model, Prototyping model, RAD model, Evolutionary software process model.

Project Management Concepts: The Management Spectrum, The People, The Product, The Process, and The Project .W5HH Principle.

Software Process and Project Metrics: Measures, Metric Indicators, Metric in process and the Project Domains ,Software Measurement, Metrics for software quality.

Unit-II

10 Hrs

Software Project Planning: Project Planning Objectives, Software Project Estimation, decomposition Techniques, Empirical Estimation Models.

Risk Analysis and Management: Software Risks, Risk Identification, Risk Projection, Risk Refinement and Risk Mitigation, Monitoring, and Management.

Unit-III

10Hrs

Analysis Concepts and Principles: Requirement analysis, communication techniques, analysis principles, software prototyping and specification.

Analysis Modeling: Elements of analysis model, data modeling, functional modeling, behavioral modeling, the mechanics of structured analysis, data dictionary, other classical analysis methods.

Unit-IV

10hrs

Design Concepts and Principles: Software design and software engineering design process, design principles, design concepts, design methods, data design, architectural design and process, transform and transaction mappings, design post processing, architectural design optimization, interface design, procedural design.

Unit-V

08 hrs

Software Testing Techniques and Strategies: Fundamentals, Test case design, White box testing, Basis path testing, Control structure testing, Black box testing, Software testing strategies.

Software Configuration Management: Configuration management, maintenance costs, maintenance side effects, maintenance tissues.

Software Quality Assurance: Quality Concepts, Software Quality Assurance, FTR, ISO 9001, ISO-9002, ISO-9003, Introduction to CASE, DOD standard 2167 A.

REFERENCES:

1. Software Engineering, Fifth Edition, Roger - Pressman, McGraw Hill.
2. Software Engineering , Ian Sommerville, International Computer Science, Series
3. Software Engineering, Schooma, McGraw Hill
4. Object Oriented Design and Analysis, Booch, Benjamin / Cummings,
5. Software Engineering: A Practitioner's Approach 7th Edition, Roger – Pressman, Tata McGraw - Hill Education (2010)

MCA 4.3: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Fundamental understanding of the history of artificial intelligence (AI) and its foundations. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
- Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.

Unit-I:

12 hrs

Introduction: Introduction to AI applications and AI techniques, Production systems, control strategies, reasoning - forward and backward chaining. Intelligent Agents: Definitions of a rational agent, reflex, model-based, goal-based, and utility-based agents, the environment in which a particular agent operates.

Unit-II:

12 hrs

Searching Techniques and Game Playing: Breadth first search, depth first search, iterative deepening, uniform cost search, hill climbing, simulated annealing, genetic algorithm search, heuristic search, Best first search, A* algorithm, AO* algorithm, Minimax and game trees, refining minimax, Alpha - Beta pruning, constraint satisfaction.

Unit-III:

10 hrs

Knowledge Representation: First order predicate calculus, resolution, unification, natural deduction system, refutation, logic programming, PROLOG, semantic networks, frame system, value inheritance, conceptual dependency, Ontologies. Planning: basic representation for planning, symbolic-centralized vs. reactive-distributed, partial order planning algorithm.

Unit-IV:

07 hrs

Machine learning: Introduction to different types of learning, Supervised and Unsupervised learning — Reinforcement learning- Basics of Neural network models.

Unit-V:

07 hrs

Applications of Artificial Intelligence-Natural Language Processing, Speech recognition, Computer vision, Expert systems.

REFERENCE:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach (3rd ed.), Pearson Education, 2010.
2. Elaine Rich and Kelvin Knight, Artificial Intelligence, Tata McGraw Hill, 2002.
3. Nils J Nilson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann Publishers, Inc., San Francisco, California, 2000.

MCA 4.4: OPERATION RESEARCH

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Formulate and solve problems as networks and graphs.
- Develop linear programming (LP) models for shortest path, maximum flow, minimal spanning tree, critical path, minimum cost flow, and transportation problems.
- Solve the problems using special solution algorithms.

UnitI

10hrs

Introduction: History, Definitions, Features of Operation Research, Models and modeling in OR, Methods for solving OR models, Advantages of OR Study. Linear Programming: Structure of Linear programming model, General Mathematical model of LPP, guidelines on linear programming models, Examples of LP model formulation.

UnitII

12hrs

Linear programming: Graphical solution Methods of LP problems, Simplex algorithm(Maximization case), Simplex algorithm (Minimization case): two phase and Big-M method. Duality in Linear programming

Unit III

10 hrs

Transportation Problem : Mathematical model of transportation problem, The transportation algorithm, NWCM, LCM, VAM, Test for optimality, variations in Transportation problem.

UnitIV

10hrs

Assignment Problem: Mathematical models of Assignment Problem, Hungarian method for solving Assignment problem. Network Models: Scope and definition of Network models, minimal spanning tree algorithm, TSP as a network model, project management :CPM and PERT.

UnitV

6hrs

Decision Theory and Decision Trees : Steps in decision making, Types of Decision making environment Decision making under uncertainty, Decision making under risk, Posterior probabilities and Bayesian Analysis, Decision Tree Analysis.

References :

1. Sharma J.K, Operations Research, Theory and Applications, McMillan IndiaLtd.
2. Hamdy A. Taha, Operations Research, 8/e, PearsonEducation.

3. Filet B. E., Introduction to Operation Research : A Computer Oriented Algorithm Approach
4. Gillet B.E, Introduction to Operations Research, TMH.
5. Chandrasekhar Salimath and Bhupender parashar, Operation Research, University Press, 2014

CORE THEORY ELECTIVES: I

Subject Code	Elective Title
MCA 3.2A	Linear Algebra
MCA 3.2B	Operating System Concepts
MCA 3.2C	Computer Graphics
MCA 3.2D	Mobile Computing
MCA 3.2E	Cloud Computing
MCA 3.2F	Business Intelligence Systems

MCA 3.2A: LINEAR ALGEBRA

Total hours-48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Solve systems of linear equations
- Use matrix algebra and the related matrices to linear transformations
- Compute and use determinants
- Compute and use eigenvectors and eigenvalues
- linear dependence and independence and spanning
- Familiar with the notion of a linear transformation and its matrix.

Unit-I

12hrs

Introduction to Vector: Vector and linear combination, Length and Dot products, Matrices.

Solving Linear Equations: Vectors and linear equations, The idea of elimination, Elimination using matrices, Rules for matrix, Inverse Matrices, Elimination=Factorization: $A=LU$, Transposes and permutations.

Unit-II

12hrs

Vector Spaces and Subspaces: Spaces of Vectors, The Null space of A, The Complete Solution to $Ax=b$, Independence, Basis and Dimension, Dimension of the Four Subspaces.

Unit-III

10hrs

Orthogonality: Orthogonality of the four subspaces, Projections, Least squares approximations, Orthogonal bases and Gram-Submidt.

Determinants: The properties of Determinants, Permutations and Cofactors, Cramer's Rule, Inverses, and Volumes.

Unit-IV

07hrs

Eigenvalues and Eigenvectors: Introduction to Eigenvalues, Diagonalizing a Matrix, Systems of Differential equations, Symmetric Matrices, Positive Definite Matrices.

Unit-V

07hrs

Single Value Decomposition (SVD): Image processing by Linear Algebra, Bases and Matrices in the SVD, Principal Component Analysis (PCA by SVD), The Geometry of the SVD.

REFERENCES:

- 1) Introduction to Linear Algebra by Gilbert Strang (5th edition), Wellesley – Cambridge press, 2016
- 2) Linear Algebra by Kenneth Hoffman and Ray Kunze (2nd edition), Prentice-Hall, 1971
- 3) Introduction to Linear Algebra by Thomas A Whitelaw, (2nd edition), Champman & Hall/ CRC, 2018
- 4) Introduction to Linear Algebra with applications by Jim De Franza & Daniel Gagliardi, Waveland Press.

MCA 3.2B: Operating System Concepts

Total hours: 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Understanding the concepts of Allocate Main Memory based on various memory management techniques
- Compare Memory allocation techniques, page replacement policies for dynamic memory management.
- Schedule CPU time using scheduling algorithm for processors. Compare various scheduling algorithms

Unit-I

10Hrs

Introduction: Operatingsystemconcepts,typesof operatingsystem–Batch,interactive, time sharing, real time and distributed operating systems. Operating system services, systemcalls,systemcomponents,systemprograms.

Process Management: Processes-process scheduling, operation on processors, co-operatingprocessthreads,interprocesscommunication,conceptof criticalsectionproblem andsolution,semaphoresandimplementation.

Unit-II

10Hrs

CPU Scheduling: Schedulingcriteria and schedulingalgorithms,multipleprocessor scheduling.

Deadlock: Deadlock

problem,characterization,prevention,avoidance,detection,recovery, combinedapproachtodeadlockhandling.

Unit-III

10 Hrs

Memory Management: Logicaland physicaladdress,swapping overlays,contiguous allocation,paging segmentation,segmentationwith paging,virtual memory-demandpaging pagereplacementalgorithms.

Unit-IV

10 Hrs

Disk and Drum Scheduling: Physical characteristics FCFS, Shortest seek time first, SCANScheduling,selectionof diskschedulingalgorithm,sectorqueuing.

Unit-V

08Hrs

File System: Files, accessmethod,directorystructure,protectionandfile system implementation,allocationmethods.

Protection: Goals,mechanismandpolicies,domanof protection,accessmatrixandits implementation,dynamicprotectionstructure,revocation,security.

REFERENCES:

1. Operating systems Concepts, Peterson, J. and Sliberschatz, McGraw Hill.2006
2. Operatingsystem, Madnick, S.E. Donovan J.J., McGraw Hill.

3. Operating system Principles, Brinch Hansen P., PHI.
4. A logical Design of Operating systems, Shaw A., PHI
5. Operating systems, Milan Milenkovic, McGraw Hill.
6. Fundamentals of Operating system, including case studies, Sridhar. R., :MS-DOS, UNIX & OS/2, Dynaram Publications.
7. Windows 3.1 A Complete Tutorial, Galgotia Publication Pvt., Ltd., Subhash Mehta.
8. Systems Programming and Operating system, McGraw Hill.

MCA3.2C:Computer Graphics

TotalHours:48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Using algorithms for scan conversion and filling of basic objects and their comparative analysis.
- Use of geometric transformations on graphics objects and their application in composite form.

Unit-I

10Hrs

Introduction: Computer graphics and its applications in various fields. Hardware system for graphics working of different input devices, visual display devices and hard copy device. Introduction to different coordinate systems.

Raster Scan display: Concepts of resolution, aspect ratio, refresh rate and frame buffer.
Random scan displays: Concepts of display file and display file interpreted comparison between raster scan and random scan. Implementation of graphics in 'C' language and study of various graphics functions.

Unit-II

10Hrs

Line drawing methods: DDA algorithm and Bresenham's algorithm for different scope conditions, midpoint method for line generation. Two-dimensional transformation: Mathematical treatment of basic transformations such as translation, scaling and rotation. Development of composite transformation matrices using homogeneous coordinates. General fixed point scaling and pivot point rotation.

Clipping: Study of Cohen Sutherland line clipping procedure and Sutherland Hodgman polygon clipping procedure.

Windows and viewports: Derivation of generalized window to viewport transformation matrix. Introduction to interrupt driven programming in 'C' and interacting with the mouse.

Unit-III

10 hrs

Three-dimensional Computer Graphics: Introduction to left and right hand coordinate systems. Basic 3D transformation. Hidden line removal. Projection: Study of orthographic and oblique parallel transformation equations for them.

Unit-IV

10 Hrs

Graphic software standards: GKS and PHIGS. Study of various attributes of output primitives such as line attributes, area fill attributes and character attributes.

Graphics Software Study: DirectX and OpenGL

Unit-V

08Hrs

Segments: Concepts and advantages. Segment table various operations on segments. Data structures for the display file array on segment, linked list and paging schemes.

Miscellaneous topics – Brief introduction to Bezier curves and their application, fractal morphing and animation.

REFERENCE:

1. Newman and Sproull: Principles of Interactive Computer Graphics McGraw Hill, 1996.

2. S.Harrington:ComputergraphicsMcGrawHill,1997.
3. YeshwantKanetkar:Graphicsunder“C”BPB,1995.
4. YeshwantKanetkar:CPearlsBPB,1996.
5. HearnDonaldPaulingBaker.M:ComputerGraphicsEEEEPHI,1998

MCA 3.2D: MOBILE COMPUTING

Total hours: 48

Upon Completion of the course, the students will be able to

- To get familiar with various generations of mobile communications.
- To understand the concept of cellular communication.
- To understand the basics of wireless communication.
- Knowledge of GSM mobile communication standard, its architecture, logical channels, advantages and limitations.

UNIT-1

10hrs

Mobile Computing Architecture: An Overview

Mobile IP, Cellular and WLAN Wi-Fi IEEE 802.11X Networks, Ad Hoc Networks, Wireless Personal Area Network, Mobile Enterprise Network, Mobile Cloud Network, Mobile Computing, Mobile Computing Operating System, Mobile Computing Architecture, Design Considerations for Mobile Computing, Mobile Computing and the Apps, Limitations of Mobile Devices, Security Issues

UNIT-2

10hrs

Mobile Client Devices and Pervasive Computing

Moving beyond Desktops, Pervasive Computing, Mobile Devices-Classifications and Characteristics, Tablet and e-Book Reader, Smart Identification Devices: Smart Cards, Labels, and Tokens, RFID, Smart Sensors, Actuators, and Mobile Robotic Systems, Smart Home and Appliances, Limitations and Devices Design Constraints, Automotive Systems

UNIT-3

10hrs

Second-generation Architecture—GSM, GPRS, and Others

GSM Services, GSM System Architecture, Call Routing, Public Land Mobile Network (PLMN) Interface, GSM Subscriber Addresses and Identities, Protocols, Localization, Call Handling, Handover, Security, Introduction to SMS, General Packet Radio Service, High-speed Circuit-switched Data

UNIT-4

10hrs

Wireless Medium Access Control, CDMA, 3G, WiMax, 4G and 5G Networks

Modulation, Medium Access Control, Exposed and Hidden Terminal Problem, Near and Far Terminal Problem, and Power Control for Medium Access, MAC Algorithms, WLAN and CAMA/CA Wireless Protocols, Applications of 3G Mobile Services, 3G Mobile Services: IMT2000 and UMTs, CDMA 2000: 3G, WCDMA 3G, OFDM, High-speed Packet Access, Long-term Evolution and WiMax 16E, 4G Networks: HS-OFDM, LTE Advanced and WiMax 16M, Upcoming 5G Network Features

UNIT-5

08hrs

Mobile IP Network Layer

Mobile IP, Packet Delivery and Handover Management, Location Management, Registration, IP Header: Encapsulation and Routes Optimization, Mobility Binding, Tunneling, and Reverse Tunneling, Dynamic Host Configuration Protocol, Cellular IP, Mobile IP with IPv6, Voice over IP, IP Security

Reference Books:

1. Raj Kamal, "Mobile Computing", 3rd edition, oxford University press.

2. Pattnaik, “Fundamentals of mobile computing”, 2nd edition, PHI
3. Uwe Hansmann, “Principles of mobile computing”, 2nd edition, Springer international, 2014

MCA 3.2E Cloud Computing

Total hours: 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Identify the technical foundations of cloud systems architectures.
- Analyze the problems and solutions to cloud application problems.
- Apply principles of best practice in cloud application design and management.
- Identify and define technical challenges for cloud applications and assess their importance.

Unit –I: New Computing Paradigms and Services

08Hrs

Edge computing, Grid computing, Utility computing, Distributed computing, Cloud computing and its history and evolution

Unit –II: Introduction to Cloud Computing

10 Hrs

Cloud Computing Architectural Framework, Cloud Deployment Models, private, public and hybrid, Challenges in adapting a cloud in the context of i) Security issues ii) Bandwidth and iii) Integration issues, Virtualization in Cloud Computing, Parallelization in Cloud Computing, Security for Cloud Computing, Cloud Economics

Unit-III : Cloud source Service Models

10 Hrs

Software as a Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Seven Business Models for cloud, five-layer cloud service stack, compute and storage cloud services case studies Jeff Bezos and Amazon

Unit -IV : Foundational Elements of Cloud Computing

10 Hrs

Virtualization, Browser as a platform, Introduction to Web 2.0, Introduction to Autonomic Systems, Service Level Agreements, Cloud Computing architecture and industry frameworks such as MapReduce.

Unit –V: Cloud Computing Practices

10 Hrs

Virtualization, Cloud Computing Operating System, Creating Windows servers on the cloud, Creating Linux servers on the cloud, Deploying applications on the cloud, Major cloud solutions.

References:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2013
2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy", O'Reilly, 2009
3. Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2011
4. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing: From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2013.
5. Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley-India, 2010

6. John W.Rittinghouse and James F.Ransome, “Cloud Computing: Implementation, Management, and Security”, CRC Press, 2010.
7. Rajkumar Buyya,Christian Vecchiola,S.Thamarai Selvi,”Mastering Cloud Computing” , Tata McGraw Hill,2013

MCA 3.2F: BUSINESS INTELLIGENCE SYSTEMS

Total hours: 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- Introduce the concepts and components of Business Intelligence (BI)
- Evaluate the technologies that make up BI (data warehousing, OLAP)
- Define how BI will help an organization and whether it will help yours
- Identify the technological architecture that makes up BI systems
- Plan the implementation of a BI system

Unit-I

12hrs.

Decision support and Business intelligence-Changing Business environment and computerized decision support, managerial decision making and support for decision making-DSS concept and framework Business intelligence-Major tools and techniques of managerial decision support –BI architecture.

Unit-II

12hrs.

Essentials of Business Intelligence-Origin and drivers of business intelligence, successful BI implementation ,characteristics of BI-Architecting the data ,Enterprise Data model and its Benefits, Granularity of Data in Data warehouse and role of Metadata

Unit-III

10hrs.

Advanced Data Warehousing principles- Data Warehousing architecture, DW development, real time DW and DW Administration and security issues-Visualization of Dimension model-Star, snowflake and other advanced models-Aggregated Fact Tables-Relational DBMS Support for Dimensional Modelling-Advanced Topics in Dimensional Modelling-Selecting a Modelling Tool-Populating Data Warehouse.

Unit-IV

07hrs.

Dimensional modelling in BI environment-Dimensional Modelling-Modelling considerations-Dimensional model design life cycle-Case studies-Business Analytics and data visualization-Business analytics overview, reports and queries, Advanced Business Analytics, data visualization Real time BI, Business analytics and web intelligence-Structure of mathematical models for decision support and visual interactive simulation.

Unit-V

07hrs.

Business performance Management-Business Intelligence Applications: Marketing models, Logistic and production models and Data Development analysis.

REFERENCES:

1. E Turban, J E Aronson, Teng pend Liang and Ramesh Sharada, “Decision Support and Business Intelligence”, 8th Edition, pearson Education, 2009.
2. Dan Volitich, ”IBM Cognos Business Intelligence”, TMH ,2008.
3. Chuck Bullard.,Dirk Herreman, Don Schau,Rhonda Bell,Eunsaeng Kim,ann Valencic, ”Data Modelling Techniques for Data Warehousing”, IBM Corporation,1999

Core Theory Electives-II

Subject Code	Elective Title
MCA 4.2A	Computer Vision
MCA 4.2B	Internet of Things (IoT)
MCA 4.2C	Mobile Communications
MCA 4.2D	Deep learning
MCA 4.2E	Information Security and Cryptography
MCA 4.2F	Soft Computing

MCA4.2A:Computer Vision

Total Hours : 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- identify basic concepts, terminology, theories, models and methods in the field of computer vision,
- describe known principles of human visual system,
- describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition,
- suggest a design of a computer vision system for a specific problem

Unit- I:

12hrs

Introduction and image processing : What is computer vision? History of computer vision, Photometric image formation, the digital camera, Image processing: Point operators, Linear filtering, Neighbor hood operators.

Unit -II:

10 hrs

Feature detection and matching : Feature detectors, feature descriptors, feature tracking, edge detection, edge linking, Lines: successive approximation, Hough transform, vanishing points, Application: Rectangel detection.

Unit-III :

10 hrs

Segmentation : Active contours: snakes, Dynamic snakes and condensation, Scissors, Level Sets. Split and merge : Watershed, Region splitting(divisive clustering), Region merging (agglomerative clustering) Graph-based segmentation.

Unit-IV :

8 hrs

Color Image processing: color fundamentals, color models, Pseudo color image processing, color transformations, color image smoothing and sharpening, Image segmentation based on color.

Unit-V:

8 hrs

Recognition : Object detection, Face recognition, Instance recognition, category recognition, context and scene understanding

References :

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003.
3. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson Education, 2013.
4. Anil K. Jain, Fundamentals of Digital image processing, Prentice-Hall of India Pvt Ltd., 1997.
5. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image processing, Analysis and Machine vision, Cengage Learning: 4th edition, 2014.

MCA 4.2B: INTERNET OF THINGS (IoT)

Total Hours: 48

Course Outcomes:

Upon Completion of the course, the students will be able to

- explain the definition and usage of the term “Internet of Things” in different contexts
- understand the key components that make up an IoT system
- differentiate between the levels of the IoT stack and be familiar with the key technologies and protocols employed at each layer of the stack
- apply the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis
- understand where the IoT concept fits within the broader ICT industry and possible future trends

Unit-1

10hrs

Introduction to IoT: what is IOT? Genesis of IoT and digitization, IOT impact, Convergence of IT and OT, IOT challenges.

IoT Network Architecture and Design: Drivers behind New Network Architectures, IoT architecture drivers, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT data management and compute stack

Unit-2

10hrs

Engineering IoT networks: Smart Objects: The “Things” in IoT, Sensors, Actuators, and Smart Objects, Wireless Sensor Networks (WSNs), Communication Protocols for Wireless Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

Unit-3

10hrs

IP as the IoT Network Layer: The Business Case for IP, The Need for Optimization, IP versions, Optimizing IP for IoT, header compression, Fragmentation, Mesh addressing, 6TiSCH, RPL, Authentication and encryption on constrained nodes.

Unit-4

10hrs

Application Protocols for IoT: The Transport Layer, IoT Application Transport Methods, Application Layer Protocol Not Present, SCADA, A Little Background on SCADA, Adapting SCADA for IP, Tunneling Legacy SCADA over IP Networks, SCADA Protocol Translation, SCADA Transport over LLNs with MAP-T, Generic Web-Based Protocols, IoT Application Layer Protocols, CoAP

Unit-5

08hrs

Data and Analytics for IoT: An Introduction to Data Analytics for IoT, Structured Versus Unstructured Data, Data in Motion Versus Data at Rest, Machine Learning Overview, Supervised Learning, Unsupervised Learning, Machine Learning and Getting Intelligence from Big Data, Predictive Analytics, Big Data Analytics Tools and Technology, Edge Analytics Core Functions, Network Analytics

References:

1. David Hanes, “IoT Fundamentals”, CiscoPress.com, 2017

2. Adrian McEwen, “ Designing Internet of things”, wiley, 2014
3. Samuel greengard, “The internet of things”, MIT press, 2015
4. Cuno Pfister, “ Getting started with internet of things”, O’Reilly, 2011

MCA 4.2C: MOBILE COMMUNICATIONS

Total Hours : 48

Course Outcome:

Upon Completion of the course, the students will be able to

- explain the basic physical and technical settings functioning of mobile communications systems,
- describe the basic principles of mobile communication system.
- conduct field experiments and measurements, and measurements in the laboratory on actual components, devices, equipment and systems,
- interpret the collected data and measurement results,
- describe the development and implementation of mobile communication systems,
- test mobile communication equipment for the technical functionality.

Unit-1

10hrs

Introduction and overview of wireless communication: Wireless Comes of Age 2, The Global Cellular Network, The Mobile Device Revolution, Future Trends, The Trouble With Wireless, Signals for Conveying Information, Analog and Digital Data Transmission, Channel Capacity, Transmission Media, Spectrum Considerations, Line-Of-Sight Transmission, Fading in the Mobile Environment, Channel Correction Mechanisms, Digital Signal Encoding Techniques, Coding and Error Control, Orthogonal Frequency Division Multiplexing (OFDM)

Unit-2

10hrs

Signal Encoding Techniques and error control: Signal Encoding Criteria, Digital Data, Analog Signals, Analog Data, Analog Signals, Analog Data, Digital Signals, Orthogonal Frequency Division Multiplexing, Orthogonal Frequency Division Multiple Access (OFDMA), Single-Carrier FDMA, Error Detection, Block Error Correction Codes, Convolutional Codes, Automatic Repeat Request

Unit-3

10hrs

Wireless LAN Technology - Overview and Motivation, IEEE 802 Architecture, IEEE 802.11 Architecture and Services, IEEE 802.11 Medium Access Control, IEEE 802.11 Physical Layers, Gigabit Wi-Fi 356
Bluetooth and IEEE 802.15- The Internet of Things, Bluetooth Motivation and Overview, Bluetooth Specifications, Bluetooth High Speed and Bluetooth Smart, IEEE 802.15, ZigBee

Unit-4

10hrs

Cellular Wireless Networks :
Principles of Cellular Networks, First-Generation Analog, Second-Generation TDMA, Second-Generation CDMA, Third-Generation Systems, Approach to 4G, LTE Architecture, Evolved Packet Core.

Unit-5

08hrs

Mobile Applications and Mobile IP - Mobile Application Platforms, Mobile App Development, Mobile Application Deployment, Mobile IP

References:

1. Cory Beard and William Stallings, “wireless communication networks and system”, Pearson, 2016
2. Jochen Schiller, “Mobile Communication”, Addison-wesley, 2016
3. Gordon stuber, “Principles of Mobile Communication”, Springer, 2013

MCA 4.2D: DEEP LEARNING
Total Hours : 48

Course Outcome:

Upon Completion of the course, the students will be able to

- Recognize the characteristics of deep learning models that are useful to solve real-world problems.
- Understand different methodologies to create application using deep nets.
- Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems.
- Implement different deep learning algorithms
- Design the test procedures to assess the efficacy of the developed model.
- Combine several models in to gain better results

Unit I : 10hrs

Introduction : Historical context and motivation for deep learning; basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, and adaptive sub-gradient method.

Unit II : 10hrs

Neural Networks : Feed forward neural networks, deep networks, regularizing a deep network, model exploration, and hyperparameter tuning.

Unit III : 8hrs

Optimization for training deep models : Challenges in Neural Network optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithm with Adaptive Learning Rates, Approximate second order Methods, Optimization Strategies and Meta-Algorithms.

Unit IV : 12hrs

Convolutional Networks and Sequence Modeling : Motivation, Convolution operation, Pooling, Variants of the Basic Convolution Function, Structured outputs, Efficient Convolution Algorithms. Sequence Modeling: Recurrent Nets Unfolding computational graphs, recurrent neural networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks, Recursive neural networks

Unit V: 8hrs

Autoencoders: Undercomplete autoencoders, regularized autoencoders, sparse autoencoders, denoising autoencoders, representational power, layer, size, and depth of autoencoders, stochastic encoders and decoders, denoising autoencoders, Learning manifolds with Autoencoders, Applications of Autoencoders.

References :

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
2. Jeff Heaton, “Deep Learning and Neural Networks”, Heaton Research Inc, 2015.

3. Deng & Yu, "Deep Learning: Methods and Applications", Now Publishers, 2013.
4. Nikhil Buduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing NextGeneration Machine Intelligence Algorithms", O'ReillyMedia, 2017.
5. Mindy L Hall, "Deep Learning", VDM Verlag, 2011.

MCA 4.2E: INFORMATION SECURITY AND CRYPTOGRAPHY

Total Hours: 48

Course Outcome:

Upon Completion of the course, the students will be able to

- To Understand Basics Of Cryptography And Network Security.
- To Be Able To Secure A Message Over Insecure Channel By Various Means.
- To Learn About How To Maintain The Confidentiality, Integrity And Availability Of A Data.
- To Understand Various Protocols For Network Security To Protect Against The Threats In The Networks.

Unit – I : Basics of Information Security 10Hrs

Information Security Overview, Threat and Attack Vectors, Types of Attacks, Common Vulnerabilities and Exposure (CVE), Security Attacks, Fundamentals of Information Security, Computer Security Concerns, Information Security Measures.

Unit –II Information Security Policies, Procedures 08 Hrs

Information Security Policies-Necessity-Key Elements and Characteristics, Security Policy Implementation, Configuration, Security Standards-Guidelines and Frameworks

Unit-III : Encryption techniques 12 Hrs

Classical Encryption Techniques Symmetric Cipher Model- Cryptography, Cryptanalysis and Brute-Force Attack, Block Ciphers and the Data Encryption Standard - Block Cipher Structure- Stream Ciphers and Block Ciphers, Feistel Cipher Structure, The Data Encryption Standard-Encryption and Decryption, Advanced Encryption Standard (AES), International Data Encryption Algorithm(IDEA).

Unit –IV : Public Key Encryption 08 Hrs

Characteristics of Public Key System; RSA Technique – Encryption-Method; Key Exchange; Diffie-Hellman Scheme; Cryptographic Hash Functions; Digital Signature – Properties of Digital Signature, Certificates; Certificate Authorities.

Unit-V : IP and Web Security 10 Hrs

IP security: Overview - Architecture – Authentication Header - Encapsulating Security Payload - Key management – Web security: Web security considerations – Secure Socket Layer and Transport Layer Security – Secure electronic transaction – Web issues.

References:

1. Cryptography and Network Security - Principles and Practice: William Stallings, Pearson Education, 6th Edition.
2. Cryptography and Network Security: AtulKahate, McGraw Hill, 3rd Edition.
3. Cryptography and Network Security: C K Shyamala, N Harini, Dr T R Padmanabhan,Wiley India, 1st Edition.
4. Cryptography and Network Security :ForouzanMukhopadhyay, McGraw Hill, 3rd Edition.

5. Information Security, Principles, and Practice: Mark Stamp, Wiley India.
6. Principles of Computer Security: WM. Arthur Conklin, Greg White, TMH.
7. Introduction to Network Security: Neal Krawetz, CENGAGE Learning.
8. Network Security and Cryptography: Bernard Menezes, CENGAGE Learning.

MCA4.2F: SOFT COMPUTING

Total Hours: 48

Course Outcome:

Upon Completion of the course, the students will be able to

- Learn About Soft Computing Techniques and Their Applications
- Analyze Various Neural Network Architectures
- Understand Perceptron's and Counter Propagation Networks.
- Define The Fuzzy Systems
- Analyze The Genetic Algorithms and Their Applications.

Unit-I

10hrs

Soft Computing and its Techniques, Soft Computing versus Hard Computing, Applications of Soft Computing in the current industry.

Unit-II

12hrs

Neural Network (NN), Biological foundation of Neural Network, Neural Model and Network Architectures, Perceptron Learning, Supervised Hebbian Learning, Back-propagation, Associative Learning, Competitive Networks, Hopfield Network, Computing with Neural Nets and applications of Neural Network.

Unit-III

10hrs

Fuzzy sets, Operations on Fuzzy sets, Fuzzy Relations, Fuzzy Measures, Applications of Fuzzy Set Theory to different branches of Science and Engineering.

Unit-IV

10hrs

Neuro Fuzzy and Soft Computing, Adaptive Neuro-Fuzzy Inference System Architecture, Hybrid Learning Algorithm, Learning methods that Cross-fertilize ANFIS and RBFN.

Unit-V

05hrs

Coactive Neuro Fuzzy Modeling, Framework Neuron Functions for Adaptive Networks, Neuro Fuzzy Spectrum, Hybridization of other techniques.

References:

1. J.S.R.Jang, C.T.Sun and E.Mizutani, Neuro-Fuzzy and Soft Computing, PHI, 2004.
2. J.Freeman and D.Skapura, Neural Networks: Algorithms, Applications and Programming Techniques, Addison-Wesley, 1991.
3. G.J.Klir and B.Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall, 1995.

4. S.Rajasekaran and G.A.V.Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI, 2003.