ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M.TECH
BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION

(Applicable for the batches admitted from 2013-14)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
KUKATPALLY, HYDERABAD – 500 085.

ACADEMIC REGULATIONS R13 FOR M. TECH. (REGULAR) DEGREE COURSE

Applicable for the students of M. Tech. (Regular) Course from the Academic Year 2013-14 and onwards

The M. Tech. Degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on candidates who are admitted to the program and who fulfil all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the University or on the basis of any other order of merit as approved by the University, subject to reservations as laid down by the Govt. from time to time.

2.0 AWARD OF M. TECH. DEGREE

2.1 A student shall be declared eligible for the award of the M. Tech. Degree, if he pursues a course of study in not less than two and not more than four academic years. However, he is permitted to write the examinations for two more years after four academic years of course work.

2.2 A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his admission, shall forfeit his seat in M. Tech. course.

2.3 The student shall register for all 88 credits and secure all the 88 credits.

2.4 The minimum instruction days in each semester are 90.

3.0 A. COURSES OF STUDY

The following specializations are offered at present for the M. Tech. course of study.

1. Advanced Manufacturing Systems
2. Aerospace Engineering/ Aeronautical Engineering
3. Automation
4. Biomedical Signal Processing and Instrumentation
5. Bio-Technology
6. CAD/CAM
7. Chemical Engineering
8. Communication Systems
9. Computer Networks
10. Computer Networks and Information Security
11. Computer Science
12. Computer Science and Engineering
13. Computers and Communication Engineering.
14. Construction Management
15. Control Engineering
16. Control Systems
17. Cyber Forensic / Cyber Security & Information Technology
18. Design for Manufacturing/ Design and Manufacturing
19. Digital Electronics and Communication Engineering.
20. Digital Electronics and Communication Systems
21. Digital Systems and Computer Electronics
22. Electrical Power Engineering
23. Electrical Power Systems
24. Electronics & Instrumentation

25. Electronics and Communication Engineering
26. Embedded Systems
27. Embedded Systems and VLSI Design
28. Energy Systems
29. Engineering Design
30. Environmental Engineering
31. Geoinformatics and Surveying Technology
32. Geotechnical Engineering.
33. Heating Ventilation & Air Conditioning.
34. Highway Engineering
35. Image Processing
36. Industrial Engineering and Management
37. Information Technology
38. Infrastructure Engineering
39. Machine Design
40. Mechatronics.
41. Microwave & Radar Engineering
42. Nano Technology
43. Neural Networks
44. Parallel Computing
45. Power and Industrial Drives
46. Power Electronics
47. Power Electronics and Electrical Drives
48. Power Engineering and Energy Systems
49. Power Plant Engineering & Energy Management
50. Power System Control and Automation
51. Power System with Emphasis H.V. Engineering / H.V. Engineering
52. Production Engineering.
53. Real Time Systems
54. Software Engineering
55. Structural Engineering
56. Systems & Signal Processing
57. Thermal Engineering.
58. Transportation Engineering
59. VLSI
60. VLSI and Embedded System/ Electronics Design Technology
61. VLSI Design
62. VLSI System Design
63. Web Technologies
64. Wireless and Mobile Communication

and any other course as approved by the University from time to time.

3.0 B. Departments offering M. Tech. Programmes with specializations are noted below:

Civil Engg.	Construction Management Environmental Engineering Geoinformatics and Surveying Technology Geotechnical Engineering Highway Engineering Infrastructure Engineering Structural Engineering Transportation Engineering
EEE	Control Engineering Control Systems Electrical Power Engineering Electrical Power Systems Power and Industrial Drives Power Electronics Power Electronics and Electrical Drives Power Engineering and Energy Systems Power Plant Engineering & Energy Management Power System Control and Automation Power System with Emphasis H.V. Engineering / H.V. Engineering
ME	Advanced Manufacturing Systems Automation CAD/CAM Design for Manufacturing/ Design and Manufacturing Energy Systems Engineering Design Heating Ventilation & Air Conditioning Industrial Engineering and Management Machine Design Mechatronics. Power Plant Engineering & Energy Management Production Engineering Thermal Engineering.
ECE	Biomedical Signal Processing and Instrumentation Communication Systems Computers and Communication Engineering. Digital Electronics and Communication Engineering. Digital Electronics and Communication Systems Digital Systems and Computer Electronics Electronics & Instrumentation Electronics and Communication Engineering Embedded Systems Embedded Systems and VLSI Design

	Microwave & Radar Engineering Systems & Signal Processing VLSI VLSI and Embedded System/ Electronics Design Technology VLSI Design VLSI System Design Wireless and Mobile Communication
CSE	Computer Networks Computer Networks and Information Security Computer Science Computer Science and Engineering Cyber Forensic / Cyber Security & Information Technology Image Processing Information Technology Neural Networks Parallel Computing Real Time Systems Software Engineering Web Technologies
Aeronautical Engg.	Aerospace Engineering / Aeronautical Engineering
Bio-technology	Bio-Technology
Chemical Engg.	Chemical Engineering
Nano Technology	Nano Technology

4.0 ATTENDANCE

The programs are offered on a unit basis with each subject being considered a unit.

4.1 A student shall be eligible to write University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

4.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be granted by the College Academic Committee.

4.3 Shortage of Attendance below 65% in aggregate shall not be condoned.

4.4 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class and their registration shall stand cancelled.

4.5 A prescribed fee shall be payable towards condonation of shortage of attendance.

4.6 A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

4.7 A candidate shall put in a minimum required attendance at least in three (3) theory subjects in the present semester to get promoted to the next semester. In order to qualify for the award of the M. Tech. Degree, the candidate shall complete all the academic requirements of the subjects, as per the course structure.

4.8 A student shall not be promoted to the next semester unless he satisfies the attendance requirements of the previous semester including the days of attendance in sports, games, NCC and NSS activities.

5.0 EVALUATION

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of Internal Evaluation and End Semester Examination.

5.1 For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the average of the marks secured in the two Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction. Each mid term examination shall be conducted for a total duration of 120 minutes with Part A as compulsory question (16 marks) which consists of four sub-questions and carries 4 marks each and Part B with 3 questions to be answered out of 5 questions each question for 8 marks. If any candidate is absent from any subject of a mid-term examination, an on-line test will be conducted for him by the University. The details of the Question Paper pattern for End Examination (Theory) is given below:

- The End semesters Examination will be conducted for 60 marks which consists of two parts viz. i).Part-A for 20 marks, ii). Part –B for 40 marks.
- Part-A is compulsory question where it consists of five questions one from each unit and carries four marks each. This will be treated as Question 1.
- Part-B consists of five Questions (numbered from 2 to 6) carries 8 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice (that means there will be two questions from each unit and the student should answer only one question)

5.2 For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations and 40 marks shall be awarded based on the day-to-day performance as Internal Marks.

5.3 There shall be two seminar presentations during I year I semester and II semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Departmental Academic Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.4 There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members of the Department. The Comprehensive Viva-Voce is intended to assess the students' understanding of various subjects he has studied during the M. Tech. course of study. The Comprehensive Viva-Voce is evaluated for 100 marks by the Committee. There are no internal marks for the Comprehensive Viva-Voce.

5.5 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.6 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.5) he has to reappear for the End semester Examination in that subject. A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and so has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled.

5.7 In case the candidate secures less than the required attendance in any subject, he shall not be permitted to write the End Examination in that subject. He shall re-register the subject when next

offered.

5.8 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher and the second examiner shall be another Laboratory Teacher.

6.0 EVALUATION OF PROJECT/DISSERTATION WORK

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

6.1 A Project Review Committee (PRC) shall be constituted with Principal as Chairperson, Heads of all the Departments offering the M. Tech. programs and two other senior faculty members.

6.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the Departmental Academic Committee for approval. Only after obtaining the approval of the Departmental Academic Committee can the student initiate the Project work.

6.4 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Departmental Academic Committee. However, the Departmental Academic Committee shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

6.5 A candidate shall submit his status report in a bound-form in two stages at least with a gap of 3 months between them.

6.6 The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Principal through Head of the Department and make an oral presentation before the PRC.

6.7 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/ School/Institute.

6.8 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.

6.9 If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected.

6.10 If the report of the examiner is favourable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work as one of the following:

A. Excellent

B. Good

C. Satisfactory

D. Unsatisfactory

The Head of the Department shall coordinate and make arrangements for the conduct of Viva- Voce examination.

If the report of the Viva-Voce is unsatisfactory, the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva- Voce examination, he will not be eligible for the award of the degree.

7.0 AWARD OF DEGREE AND CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

Class Awarded	% of marks to be secured
First Class with Distinction	70% and above
First Class	Below 70% but not less than 60%
Second Class	Below 60% but not less than 50%
Pass Class	Below 50% but not less than 40%

The marks in internal evaluation and end examination shall be shown separately in the memorandum of marks.

8.0 WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the university or if any case of indiscipline is pending against him, the result of the student will be withheld and he will not be allowed into the next semester. His degree will be withheld in such cases.

9.0 TRANSITORY REGULATIONS

9.1 Discontinued, detained, or failed candidates are eligible for admission to two earlier or equivalent subjects at a time as and when offered.

9.2 The candidate who fails in any subject will be given two chances to pass the same subject; otherwise, he has to identify an equivalent subject as per R13 academic regulations.

10. GENERAL

10.1 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

10.2 The academic regulation should be read as a whole for the purpose of any interpretation.

10.3 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

10.4 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/ year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.

4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions : (if the squad reports that the college is also involved in encouraging malpractices)
   - (i) A show cause notice shall be issued to the college.
   - (ii) Impose a suitable fine on the college.
   - (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.TECH - BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION

COURSE STRUCTURE AND SYLLABUS

I Year I Semester

Code	Group	Subject	L	P	Credits
		Medical Image Processing	3	-	3
		Real Time Signal Processing	3	-	3
		Virtual Instrumentation	3	-	3
		Bio Sensors	3	-	3
	Elective –I	Physiology For Engineers * Bioinformatics And Applications Electronic System Design	3	-	3
	Elective -II	Clinical Instrumentation * Neural Networks And Fuzzy Logic Biostatistics	3	-	3
	Lab	Biomedical and Virtual Instrumentation Lab	-	3	2
		Seminar	-	-	2
		Total Credits	18	3	22

I Year II Semester

Code	Group	Subject	L	P	Credits
		Advanced Biomedical Signal Processing	3	-	3
		Advanced Medical Imaging	3	-	3
		Fiber Optics And Laser Instrumentation	3	-	3
		Digital Signal Processors And Architectures	3	-	3
	Elective–III	Adaptive Signal Processing Sensors and Actuators Design and Analysis of Signal Conditioning Circuits	3	-	3
	Elective-IV	Biomems And Nanotechnology Speech Processing Rehabilitation Engineering	3	-	3
	Lab	Advanced Medical Signal & Image Processing Lab	-	3	2
		Seminar	-	-	2
		Total Credits	18	3	22

II Year - I Semester

Code	Group	Subject	L	P	Credits
		Comprehensive Viva	-	-	2
		Project Seminar	-	3	2
		Project work	-	-	18
		Total Credits	-	3	22

II Year - II Semester

Code	Group	Subject	L	P	Credits
		Project work and Seminar	-	-	22
		Total Credits	-	-	22

* Compulsory for students with ECE & EEE background.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

MEDICAL IMAGE PROCESSING

UNIT-I

Digitized image functions, Dirac distributions, convolution, Fourier transform, Images as linear system. Image digitization, sampling, Quantization, color images. Digital image properties, Metric and topological properties, Histogram visual perception, Image quality, Noise. Data structures for image analysis, data representation, traditional and hierarchical data structures.

UNIT-II

Image Enhancement. Contrast manipulation, histogram equalization, Laplacian derivatives, Sobel and Klisch operators, rank operators –textural analysis. Image pre processing – pixel brightness transformations, Geometric transformations, local pre processing, Image restoration. Imaging filters.

UNIT-III

Thresholding and Segmentation. Detection methods, optimal thresholding, multi-spectral thresholding. Edge based segmentation, Region based segmentation, Matching, Advanced optimal border and surface detection approaches.

UNIT-IV

Restoration. Deterministic, geometric linear filtration, inverse filtering, power spectrum equalization, stochastic. Wiener filtering. Registration, anatomy based, object based, scene based.

UNIT-V

Mathematical morphology. Basic morphological concepts, Morphological principles: Binary dilation and erosion, Gray scale dilation and erosion, skeletons and object marking, graundometry, Morphological segmentation and water sheds.

TEXTBOOKS:

1. John C Russ, The image processing handbook, CRC and IEEE press –1999.
2. Milan Sonka, Vaclav Hlavac,Roger Boyle, Image processing, analysis and machine vision, 2nd edition,Brooks/Cole publishing Co., 1999.

REFERENCES:

1. Jayaram, Kudupa and Gabor,T Herman, 3D imaging in medicine, 2nd edition, CRC press, 2000.
2. Craig A.Hindley, Practical image processing in C, John Wiley and Sons 1991.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

REAL TIME SIGNAL PROCESSING

UNIT I

Review of Basics: Discrete time processing of continuous signals - Structure of a digital filter; Frequency domain analysis of a digital filter; Quantization error; Sigma and Sigma Delta Modulation. Fourier Analysis – DFT, DTFT, DFT as an estimate of the DTFT for Spectral estimation. DFT for convolution, DFT/DCT for compression, FFT. Ideal Vs non ideal filters, FIR and IIR Filters Digital Filter Implementation; Elementary Operations.

UNIT II

Real Time Transforms: Discrete Cosine Transform, Walsh Transform, Hadamard Transform and Wavelet Transform.

Digital Filters –, State Space realization, Robust implementation of Digital Filters, Robust implementation of equi – ripple FIR digital filters.

UNIT III

Multirate Signal Processing: Concepts of multirate signal processing, Software implementation of sampling rate converters – decimators and interpolators, Sample rate conversion using polyphase filter structure.

UNIT IV :

Adaptive Digital Filters: Concepts of Adaptive filtering, Wiener filter theory, LMS adaptive algorithm, Recursive least square algorithm, Applications – Adaptive filtering of Ocular artifacts from human EEG and Fetal monitoring.

UNIT V :

Digital Signal Processors: Fixed point and Floating point digital signal processors, Architecture of TMS C54XX processor, Addressing modes, Implementation of DSP algorithms: Convolution, correlation, FIR filter, IIR filter, Decimation and Interpolation techniques, FFT processing, Adaptive filtering (LMS algorithm).

TEXT BOOKS:

1. Roberto Cristi, "**Modern Digital Signal Processing**", Cengage Publishers, India, (erstwhile Thompson Publications), 2003.
2. **"Digital Signal Processing"**, Emmanuel C Ifeachor and Barrie W Jervis, 2nd Edition, Pearson Education 2004.
3. **" Real time digital signal processing: Fundamentals, Algorithms and implementation using TMS processor ",** V.Udayashankara, PHI, New Delhi, 2010.

REFERENCE BOOKS:

1. **"Digital Signal Processing"**, Avtar Singh and S Srinivasan, Thomson Publishing 2004, Singapore
2. **"Optimum Signal Processing"**, S J Orfanides, Second edition, McGraw Hill, 1989.
3. **"Digital Signal Processors"**, B Venkataramani and M Bhaskar, TMH, New Delhi 2002.
4. S.K. Mitra, "**Digital Signal Processing: A Computer Based Approach¡¬**, III Ed, Tata McGraw Hill, India, 2007.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

VIRTUAL INSTRUMENTATION

UNIT- I

Virtual Instrumentation: An Introduction : Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems.

UNIT- II

VI Programming Techniques: VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT- III

Data Acquisition Basics: Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. DC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

UNIT -IV

VI Interface Requirements: Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT- V

VI Toolsets: Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

TEXTBOOKS

1. LabVIEW Graphical Programming, Gary Johnson, Second edition, McGraw Hill, Newyork, 1997.
2. LabVIEW based Advanced Instrumentation Systems, S. Sumathi and P. Surekha, Spinger.

REFERENCES

1. PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Kevin James, Newnes, 2000.
2. WEB RESOURCES: www.ni.com.
3. LabVIEW for everyone, Lisa K. wells & Jeffrey Travis Prentice Hall, New Jersey, 199

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

BIOSENSORS

UNIT-I :

Principles of transduction and measurement, Sensor Classification, Medically significant measurands-strain, force, pressure, acceleration, flow, volume, temperature and biopotentials. Functional specifications of medical sensors; static and dynamic characteristics of measurement systems. Primary sensors.

UNIT – II :

Resistive sensors. Potentiometers, Strain gages, RTDs, Thermistors, LDR. Signal conditioning. Wheatstone bridge, balance and deflection measurements. Instrumentation amplifier. Interference types and reduction. Shield grounding. Isolation amplifiers.

UNIT-III :

Reaction variation and electromagnetic sensors. Capacitive sensors, inductive sensors, LVDT, electromagnetic sensors. Signal conditioning, AC bridges, AC amplifiers, electrostatic shields, carrier amplifiers, phase-sensitive detectors.

UNIT-IV :

Self-generating sensors. Thermoelectric sensors, thermocouples, piezoelectric sensors, photovoltaic sensors. Signal conditioning. chopper and low-drift amplifiers, Noise in op-amps. Digital sensors. Telemetry and data acquisition.

UNIT-V :

BioMicroElectroMechanical Systems (BioMEMS). Principles, design, fabrication and application of micro- and nano-devices to instrument and control biological molecules, living cells, and small organisms. Development of micro fabricated systems, lab-on-a-chip, and micro- and nano-biosensors.

TEXTBOOKS:

1. Ramon Pallas-Areny and John G. Webster, Sensors and signal conditioning, John Wiley and Sons, 1991.
2. **DVS Murthy**, **Transducers** for **Instrumentation** Systems, 2nd edition, Prentice Hall of India Ltd, 2004

REFERENCES:

1. John G. Webster, Medical Instrumentation-Application and Design, John Wiley and Sons Inc., 3rd Ed., 2003.
2. Rangan C.S., Sarma G.R., and Mani V.S.V., “Instrumentation devices and system”, Tata McGraw Hill Publishing Company limited, New Delhi, 2006.
3. A.P.F. Turner, I. Karube & G.S. Wilson, “Biosensors : Fundamentals & Applications”, Oxford University Press, Oxford, 1987.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

PHYSIOLOGY FOR ENGINEERS

(ELECTIVE-I)

UNIT I :

General Physiology & Respiratory System Physiology: Cell, Cell junctions, Transport through cell membrane, Homeostasis, Acid base balance. Physiological anatomy of respiratory tract, Pulmonary circulation, Mechanics of respiration, Pulmonary function tests, Ventilation, Exchange of respiratory gases, Transport of respiratory gases, Regulation of respiration, Artificial respiration.

UNIT II :

Renal Physiology : Kidney, Nephron, Juxtaglomerular apparatus, Renal circulation, Urine formation, Concentration of urine, Acidification of urine, Renal function tests, Renal disorders, Micturition, Uro flow studies, Dialysis.

UNIT III :

Cardiovascular System : Introduction to cardiovascular system, Properties of cardiac muscle, Cardiac cycle, Heart sounds, Cardiac murmurs, Electrocardiogram, Vector, Arrhythmia, Cardiac output, Regulation of heart rate, Hemodynamics, Arterial blood pressure, Hemorrhage.

UNIT IV :

GIS & Nervous System: GIS, Functions of stomach, pancreas, liver, intestine, function tests: endoscopies.

Introduction to nervous system, Neuron, Classification of nerve fibers, Properties of nerve fibers, Degeneration & regeneration of nerve fibers, Neuroglia, Receptors, Synapse, Neurotransmitters, Reflex activity, Physiology of pain, Hypothalamus, Electroencephalogram, Physiology of sleep, Epilepsy, cerebrospinal fluid, Autonomic nervous system and ANS tests. Evoked potentials. Cerebral circulation and tests.

UNIT V :

Muscle Physiology : Classification of muscles, Structure of skeletal muscles, Properties of skeletal muscles, Changes during muscular contraction, Neuromuscular junction, Electromyogram & disorders of skeletal muscles. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, joints of hands and fingers, Hip joint, Knee joint, ankle joint, joints of foot and toes.

TEXTBOOKS:

1. Principles of Anatomy and Physiology by Gerard J. Tortora and Bryan H. Derrickson (Wiley 13th Edition)
2. J Gibson; Modern Physiology & Anatomy for Nurses; Black-well Scientific Publishers, 1981.

REFERENCES:

1. Best and Taylor, Physiological basis of Medical practice, The Living Body, B.I. Publication, 1980.
2. Walter Boron, Textbook of Medical Physiology , Publisher: W.B. Saunders Company, 2008
3. **"Concise Medical Physiology"** Sujit K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

BIOINFORMATICS AND APPLICATIONS

(ELECTIVE-I)

UNIT I

The Central Dogma & XML (Bio XML) for Bioinformatics : Watson's definition, information flow, from data to knowledge, Convergence, the organization of DNA, the organization of Proteins.

Introduction, Differences between HTML and XML, fundamentals of XML, fundamentals of XML namespaces. Introduction to DTDs, Document type Declarations, Declaring elements, declaring attributes, working with entities XML Schemas, Essential Concepts, working with simple types, working with complex types, Basic namespaces issues.

UNIT II

Perl (Bioperl) for Bioinformatics : Representing sequence data, program to store a DNA sequence, concatenating DNA fragments, Transcription, Calculating the reverse complement in Perl, Proteins, files, reading proteins in files, Arrays, Flow control, finding motifs, counting Nucleotides, exploding strings into arrays, operating on strings, writing to files, subroutines and bugs.

UNIT III

Databases : Flat file, Relational, object oriented databases, object Relational and Hypertext, Data life cycle, Database Technology, Database Architecture, Database Management Systems and Interfaces.

UNIT IV

Sequence Alignment Algorithms : Biological motivations of sequence analysis, the models for sequence analysis and their biological motivation, global alignment, local alignment, End free-space alignment and gap penalty, Sequence Analysis tools and techniques.

UNIT V

Phylogenetic Analysis : Introduction, methods of Phylogenetic analysis, distance methods, the neighbor-Joining (NJ) method, The Fitch/ Margoliash method, character-based methods, Other methods, Tree evaluation and problems in phylogenetic analysis.

Clustering, Protein structure visualization and Protein structure prediction.

TEXT BOOKS:

1. **"Bioinformatics Methods and Applications",** S.C.Rastogi, N. Mendiratta, CBS publications, 2004
2. **"Beginning Perl for Bioinformatics"** James D. Tisdall, O'Reilly media, first edition, 2001

REFERENCE BOOKS:

1. **"Bioinformatics"** D.R. Westhead, J.H. Parish, Viva books private limited, New Delhi (2003)
2. **"Bioinformatics"** AttWood, pearson education, 2004
3. **"Bioinformatics Computing"** Bryan Bergeron, M.D, Pearson education, 2003

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

ELECTRONIC SYSTEM DESIGN

(ELECTIVE-I)

UNIT-I :

Analog and digital circuit design of circuits for biomedical applications using operational amplifiers, data acquisition, conversion, and interface to microcomputers. Patient safety, patient isolation circuits. Operating principles of various types of patient isolation circuitry. Most suitable isolation circuit for a given application. Test isolation circuits.

UNIT-II :

Data acquisition, Sample and Hold Conversion, Multi Channel acquisition, High speed sampling in ADC, Selection of drive amplifier for ADC performance, Gain setting and level shifting, ADC input protection, Multichannel channel applications for data acquisition systems, External protection of amplifiers, High speed ADC architectures.

UNIT-III :

Interference and noise reduction techniques. Types of noise-Thermal noise, shot noise, excess noise, Burst, Internal noise in OPAMPs, Noise issues in high speed applications, . Causes of noise and interference encountered in medical equipment. Manifestation of noise or interference. Techniques for minimizing the impact of noise or interference when using various types of medical equipment.

UNIT-IV :

Hardware approach to digital signal processing, Coherent and non-coherent sampling, Digital signal processing techniques, DSP hardware, ALU, Multipliers, accumulators, data address generators, serial ports, system interfacing ADC's and DAC's to DSPs. Interfacing IO ports to DSPs.

UNIT-V :

Use of telemetry in a medical environment.. Available frequency bands and licensing requirements for RF telemetry environments. Typical telemetry methods used in medical applications. Common problems with telemetry installations. Battery management procedures. Types of batteries used in medical equipment. Typical shelf life of common batteries. Applications for common batteries. Techniques to improve life of batteries. Test equipment for correct function after battery replacement.

TEXT BOOKS:

1. Halit Eren, Electronic portable instruments-Design and applications, CRC Press, 2004.
2. Robert B. Northrop, Analysis and application of analog electronic circuits to biomedical instrumentation, CRC Press, 2004.

REFERENCE:

1. Reinaldo J . Perez, Design of medical electronic devices, Academic press, 2002.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

CLINICAL INSTRUMENTATION

(ELECTIVE-II)

UNIT I

Bioelectric Signals and Electrodes : Sources of biomedical signals, basic medical instrumentation system, PC based medical instruments, General constraints in design of medical instrumentation systems, origin of bioelectric signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes.

UNIT II

Biomedical Recording Systems & Recorders : Electrocardiograph-block diagram, ECG leads, effects of artifacts, multi-channel, ECG machine, Vectorcardiograph, Phonocardiograph-origin of heart sounds, microphones and amplifiers for PCG, Electroencephalograph- block diagram, computerized analysis of EEG, Electromyograph, biofeedback instrumentation.

UNIT III

Oximeters, Blood Flow & Cardiac Output Measurement : Oximetry- In-vitro & in-vivo, ear oximetry, pulse oximetry, skin reflectance oximeters, intravascular oximeter. Electromagnetic blood flowmeter- principle, square wave electromagnetic flowmeter, Doppler shift ultrasonic flowmeter, flow measurement by Doppler imaging, NMR & Laser Doppler flowmeter, Cardiac output measurement- Indicator & dye dilution technique, impedance method, ultrasound method.

UNIT IV

Pacemakers & Defibrillator: Need for cardiac pacemaker, external pacemaker, implantable pacemakers-types, ventricular synchronous demand pacemaker, programmable pacemaker, power sources for implantable pacemakers. Need for defibrillator, DC defibrillator, automatic external defibrillator, implantable defibrillators

UNIT V

Advanced Diagnostic & Therapeutic Instruments : Principle of surgical diathermy & surgical diathermy machine, Electrodiagnosis-Electrotherapy-functional block diagram and working, interferential current therapy. Artificial kidney-Principle and haemodialysis machine. Lithotriptors- principle, modern lithotriptor-block diagram and working. Anesthesia-Need for anesthesia, delivery of anesthesia, anesthesia machine. Infusion pumps-principle and programmable volumetric infusion pump. Principle of endoscopy and laproscopy.

TEXTBOOKS :

1. **"Handbook of Biomedical Instrumentation"** R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003
2. Medical Instrumentation Application and Design by John G. Webster, Willey, 4th edition.

REFERENCE BOOKS:

1. **"Introduction to Biomedical Equipment Technology"** Joseph J. Carr and John M. Brown, 4th Edition, Prentice Hall, 2001.
2. Principles of Applied Biomedical Instrumentation, 3rd Edition. L. A. Geddes, L. E.Baker, Willey, 2008.
3. **"Biomedical Transducers and Instruments"** Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, 1st edition, CRC Press, 1997.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

NEURAL NETWORKS AND FUZZY LOGIC

(ELECTIVE-II)

UNIT – I :

Learning and Soft Computing: Examples, basic tools of soft computing, basic mathematics of soft computing, learning and statistical approaches to regression and classification.

UNIT – II :

Single Layer Networks & Multilayer Perception: Perception, adaptive linear neuron (Adaline) and the LMS algorithm.

Error back propagation algorithm, generalized delta rule, practical aspects of error back propagation algorithm.

UNIT – III :

Radial Basis Function Networks: ill posed problems and regularization technique, stabilizers and basis functions, generalized radial basis function networks.

UNIT – IV :

Fuzzy Logic Systems : Basics of fuzzy logic theory, mathematical similarities between neural networks and fuzzy logic models, fuzzy additive models.

UNIT – V :

Support Vector Machines : Risk minimization principles and the concept of uniform convergence, VC dimension, structural risk minimization, support vector machine algorithms.

TEXT BOOKS:

1. Artificial Neural Network, Dr.B. Yegnanarayana, Pearson Edu in, PHI,New Delhi,1999.
2. Introduction to Artificial Neural system, J.M.Zurada, Jaico Publications,1994
3. Bart Kosko, "**Neural Networks and Fuzzy Systems"** prentice Hall of India, 2005

REFERENCE BOOKS:

1. S.Haykin, "**Neural networks: A Comprehensive Foundation**"' Pearson Education (Asia) Pte. Ltd/Prentice Hall of India, 2003.
2. Vojislav Kecman, "**Learning and soft computing**", Pearson Education (Asia) Pte. Ltd.2004.
3. M.T.Hagan, H.B.Demuth and M. Beale, "**Neural Network Design**", Thomson Learning, 2002.
4. George J. Klir and Bo yaun, "**Fuzzy sets and Fuzzy Logic:Theory and Application**", Prentice Hall of India, 2001.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

BIOSTATISTICS

(ELECTIVE-II)

UNIT- I

Concepts of Biostatistics. Basic statistical measures, measures of central tendency, measures of dispersion, variance, standard deviation, properties of probability, probability distributions, sampling distributions.

UNIT- II

Estimation and hypothesis testing. confidence intervals for data, t distribution, determination of sample size for estimating means and proportions. Hypothesis testing for a single population mean/proportion difference between two population means/proportions, sample size to control type I and type II errors.

UNIT- III

Analysis of variance. The completely randomized design, random sized complete block design, repeated measures design.

UNIT- IV

Regression and correlation. Simple linear regression model, regression equation, the correlation model, multiple linear regression model, multiple regression equation, multiple correlation model, additional techniques of regression analysis.

UNIT- V

Chi-square distribution, tests of good fit, independence, homogeneity, non-parametric statistical procedures, regression analysis.

TEXTBOOKS:

1. Stanton A. Glantz, Primer of biostatistics, Mc Graw Hill , 2nd Ed.
2. Wayne S. Daniel, Biostatistics: A foundation for analysis in the health sciences, John Wiley & Sons, 6th Ed.

REFERENCES:

1. Text book of Biostatistics, A.K.Sharma, DPH Mathematics series,2005
2. Bernard Rosner's Fundamentals Of **Biostatistics, 6th** edition, Thomson Coporation, 2006.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (BMSP &I)

BIOMEDICAL AND VIRTUAL INSTRUMENTATION LAB

LIST OF EXPERIMENTS

Biomedical Instrumentation

1. Design of ECG Amplifier using Instrumentation Amplifier
2. ECG Recording and Heart rate measurement
3. Study of Electrical activities of Skeletal Muscles
4. Respiration Rate Measurement.
5. Demonstration of Defibrillator, Pacemaker, Heart lung machine, Hemodialysis and Short wave Diathermy.

Virtual Instrumentation

1. Design of decimal counter and function generator
2. Design of filters using NIELVIS
3. Signal processing with speed 33 (Speech recording and analysis)
4. Image processing application with vision assistant
5. Profiling VI Execution time and memory usage
6. Extending Virtual memory usage for 32-bit windows.
7. Characteristics of an ideal filter.
8. Comparison of FIR and IIR filters.
9. Non linear filter
10. Selection and design of a digital filter design.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

ADVANCE BIOMEDICAL SIGNAL PROCESSING

UNIT-I

Fundamentals of Discrete-Time signals and systems: Concepts of system, signal. Sampling Process. Impulse Response. Z-Transform, Discrete Transfer function, Discrete Fourier Transform(DFT), Fast Fourier Transform(FFT). Medical Applications

UNIT-II

The Electroencephalogram(EEG): Applications, Signal Processing, Modeling and Artifacts. Nonparametric and Model-based spectral analysis, EEG segmentation, Joint Time-Frequency Analysis. Evoked Potential Modalities, Noise Characteristics, Noise reduction by Ensemble Averaging and Linear Filtering, Single-Trail Analysis and adaptive Analysis Using Basis Functions

UNIT-III

Wavelets : Continuous Wavelet Transform. Discrete wavelet transform. Reconstruction. Recursive multi resolution decomposition. Types of wavelets-Haar wavelet, Daubechies wavelet, Biorthogonal wavelet. Coislet wavelet, Morlet wavelet, Mexican Hat wavelet, Symlet wavelet. Medical applications

UNIT-IV

The Electromyogram (EMG) : The electrical Activity of Muscles, Amplitude Estimation in the surface EMG, Spectral Analysis of the surface EMG, Conduction velocity Estimation, Modeling the EMG, EMG Signal Decomposition

UNIT-V

The Electrocardiogram (ECG): Heart Rhythms, Heart beat Morphologies, Noise and Artifacts, Baseline Wander, Power line interference, Muscle Noise Filtering, QRS Detection, Wave Delineation, Data Compression, Heart Rate Variability, Acquisition and RR Interval conditioning , Spectral Analysis of Heart Rate Variability.

TEXTBOOKS:

1. Leif Sornmo and Pablo Laguna, Bioelectrical Signal Processing in Cardiac and Neurological Applications, Academic Press, 2005
2. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice-Hall, 1993.

REFERENCES:

1. Rangaraj M. Rangayyan, Akay Metin(Editor),Biomedical Signal Analysis: A Case Study Approach, Wiley Interscience, 2001.
2. Roberto Cristi, Modern Digital Signal Processing.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

ADVANCED MEDICAL IMAGING

UNIT-I

Basic Medical Imaging Modalities: X-ray, CT , Ultrasound, MRI, PET-CT, SPECT-CT, Gamma Camera, Catheterization Lab. Aspects of light imaging, convolutions and transforms, photometry lenses and depth of field, Image perception and 3D Imaging, Image acquisition, Display, Image processing operations, scanning & segmentation.

UNIT-II

Computed Tomography: Basic concepts of CT , Non Spiral CT technology, Concepts of Spiral CT Scanner , Multi Slice spiral technology , Various Peripheral devices. Applications:Multiplanar Reconstruction, Maximum Intensity Projection, 3D, CT Angio, Osteo , Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Cardiac CT (Calcium scoring, Coronary Angiography, Lesion Quantification).

UNIT-III

Ultrasound Imaging: Principles of Ultrasound, Basic Ultrasound instrumentation, Image Characteristics: Ultrasonic Texture, Speckle reduction, Compensation of Phase Aberration, Tissue Characterization. Imaging techniques: (A mode, B Mode, 2B, B/M, 4B , Gated Mode, 3D, 4D, M-Mode, Echocardiography) ,Doppler Methods, Image recording devices, Image artifact, Biological effects.

UNIT-IV

Magnetic Resonance Imaging: Permanent & Super conducting magnets, Signal generation and detection, signal characteristics, signal localization, Fourier transforms in MRI, Imaging Reconstruction. Image artifacts. Coil technology, Parallel acquisition techniques, Various peripheral devices. Applications: Functional Imaging, Perfusion & Diffusion imaging (Echo planar imaging), Multi direction diffusion tensor imaging, Single & Multi Voxel Spectroscopy, MR Angiography, MRCP, Cardiac MRI (Myocardium viability, Valve function etc.,), Flow Quantification.

UNIT-V

Gamma Camera: Physics of Gamma camera, basic Instrumentation, Imaging techniques, SPECT & Whole Body studies. Applications of Gamma camera in Cardiology, Nephrology, Neurology etc.,

PET: Fundamentals of PET scanner & PET- CT, Crystal technology, Cyclotron principle, Hot Lab equipments. Applications of PET: Cardiology, Neurology & Cardiology.

TEXTBOOKS:

1. Webb's Physics of Medical Imaging, Second Edition M.A.Flower-CRC press, 2012
2. Principles of Medical Imaging by K Kirk Shung, Benjamin Tsui, Michael B Smith, Academic Press Limited, 1992.

REFRENCES:

1. Hykes, Heorick, Starchman, Ultrasound physics and Instrumentation MOSBY year book, 2nd Ed., 1992.
2. Stewart C.Bushong, Magnetic Resonance Imaging- physical and biological principles, MOSBY, 2nd Ed.,1995.

3. Zhi-Pei Laing and Paul C.Lauterbur, Principles of Magnetic Resonance imaging –A signal processing perspective, Metin Akay (Editor), IEEE press, New York, 2000.
4. Avinash C. Kak, Principles of Computerised Tomographic Imaging. IEEE PRESS
5. Willi A. Kalender, Computed Tomography, third edition,Wiley,2011.
6. Emerging Imaging Technologies in Medicine by Mark A. Anasvasio, CRC Press, 2012.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

FIBER OPTICS AND LASER INSTRUMENTATION

UNIT -I:

Optical fibers and their properties : Introduction to Optical Fibers - principles of light propagation through a fiber – Different types of fibers and their properties –Transmission characteristics of optical fiber –Absorption losses – Scattering losses – Dispersion- advantages and disadvantages of optical fibers. Light sources for fiber optics, photo detectors, source coupling, splicing and connectors.

UNIT-II:

Laser Fundamentals : Fundamental characteristics of Lasers – Three level and four level lasers – Properties of Laser and Laser modes – Resonator configuration – Q-switching and Mode locking – Cavity dumping – Types of lasers: Gas lasers, Solid lasers, Liquid lasers – Semi conductor lasers.

UNIT-III:

Industrial Applications of Optical fibers and Lasers : Fiber optic sensors – Fiber optic Instrumentation system - Interferometric method of measurement of length - Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain. Fiber optic gyroscope – polarization maintaining fibers - applications. Industrial applications of lasers – Laser Doppler Velocity meter – Laser heating

UNIT-IV:

Holography : Holography – Basic principle; methods, Holographic Components, Holographic Interferometry and Applications, Holography for Non-destructive Testing

Opto-Electronic Components : Magneto Optic and Acoustic – optic and other types of Optical Modulators – Detectors – Application in Instrumentation

UNIT-V:

Medical Applications of Laser : Medical Applications Lasers - Laser and Tissue interaction, Laser instruments for surgery, Removal of tumors of vocal cords, Brain surgery, Plastic surgery, Gynecology, Oncology, Dermatology and Ophthalmology.

TEXT BOOKS:

1. Leon Goldman “The Biomedical laser technology and clinical Applications’, Springer Verlag,1981
2. Industrial Applications of Lasers, John F Ready, Academic Press 1978
3. Laser Applications, MonteRoss, McGraw Hill, 1968

REFERENCES:

1. Semi Conductor Opto-electronics by Asprit Singh, McGraw Hill, 1995
2. Optical Electronics Foundation Book by Ghatak A.K. and Thiagarajar K, TMH, New Delhi, 1991
3. Optical Fiber Communications by Gerd Keiser, 4th Edition, Mc Graw Hill,2008
4. Lasers and Applications by Guimaran W.O.N & Mooradian A, Spinger Verlag.
5. Laser Electronics by Verdeyn JT, Prentice Hall.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

DIGITAL SIGNAL PROCESSORS AND ARCHITECTURES

UNIT –I:

Introduction to Digital Signal Processing: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time-invariant systems, Digital filters, Decimation and interpolation.

Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.

UNIT –II:

Architectures for Programmable DSP Devices: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation UNIT, Programmability and Program Execution, Speed Issues, Features for External interfacing.

UNIT -III:

Programmable Digital Signal Processors: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and Programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline operation of TMS320C54XX Processors.

UNIT –IV:

Analog Devices Family of DSP Devices: Analog Devices Family of DSP Devices – ALU and MAC block diagram, Shifter Instruction, Base Architecture of ADSP 2100, ADSP-2181 high performance Processor.

Introduction to Blackfin Processor - The Blackfin Processor, Introduction to Micro Signal Architecture, Overview of Hardware Processing Units and Register files, Address Arithmetic Unit, Control Unit, Bus Architecture and Memory, Basic Peripherals.

UNIT –V:

Interfacing Memory and I/O Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).

TEXT BOOKS:

1. Digital Signal Processing – Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. A Practical Approach to Digital Signal Processing - K Padmanabhan, R. Vijayarajeswaran, Ananthi. S, New Age International, 2006/2009
3. Embedded Signal Processing with the Micro Signal Architecture, Publisher: Woon-Seng Gan, Sen M. Kuo, Wiley-IEEE Press, 2007

REFERENCE BOOKS:

1. Digital Signal Processors, Architecture, Programming and Applications – B. Venkataramani and M. Bhaskar, 2002, TMH.
2. Digital Signal Processing – Jonatham Stein, 2005, John Wiley.

3. DSP Processor Fundamentals, Architectures & Features – Lapsley et al. 2000, S. Chand &Co.
4. Digital Signal Processing Applications Using the ADSP-2100 Family by The Applications Engineering Staff of Analog Devices, DSP Division, Edited by Amy Mar, PHI.
5. The Scientist and Engineer's Guide to Digital Signal Processing by Steven W. Smith, Ph.D., California Technical Publishing, ISBN 0-9660176-3-3, 1997.
6. Embedded Media Processing by David J. Katz and Rick Gentile of Analog Devices, Newnes, ISBN 0750679123, 2005.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

ADAPTIVE SIGNAL PROCESSING

(ELECTIVE-III)

UNIT –I:

Introduction to Adaptive Systems: Adaptive Systems: Definitions, Characteristics, Applications, Example of an Adaptive System. The Adaptive Linear Combiner - Description, Weight Vectors, Desired Response Performance function - Gradient & Mean Square Error.

UNIT –II:

Development of Adaptive Filter Theory & Searching the Performance surface: Introduction to Filtering - Smoothing and Prediction – Linear Optimum Filtering, Problem statement, Principle of Orthogonality - Minimum Mean Square Error, Wiener- Hopf equations, Error Performance - Minimum Mean Square Error.

Searching the performance surface – Methods & Ideas of Gradient Search methods - Gradient Searching Algorithm & its Solution - Stability & Rate of convergence – Learning Curves.

UNIT –III:

Steepest Descent Algorithms: Gradient Search by Newton's Method, Method of Steepest Descent, Comparison of Learning Curves.

UNIT –IV:

LMS Algorithm & Applications: Overview - LMS Adaptation algorithms, Stability & Performance analysis of LMS Algorithms - LMS Gradient & Stochastic algorithms - Convergence of LMS algorithm.

Applications: Noise cancellation – Cancellation of Echoes in long distance telephone circuits, Adaptive Beam forming.

UNIT –V:

Kalman Filtering: Introduction to RLS Algorithm, Statement of Kalman filtering problem, The Innovation Process, Estimation of State using the Innovation Process- Expression of Kalman Gain, Filtering Examples using Kalman filtering.

TEXT BOOKS:

1. Adaptive Signal Processing - Bernard Widrow, Samuel D.Strearns, 2005, PE.
2. Adaptive Filter Theory - Simon Haykin-, 4th Ed., 2002, PE Asia.

REFERENCE BOOKS:

1. Optimum signal processing: An introduction - Sophocles. J. Orfamadis, 2nd Ed., 1988, McGraw-Hill, New York
2. Adaptive signal processing-Theory and Applications - S.Thomas Alexander, 1986, Springer – Verlag.
3. Signal analysis – Candy, Mc Graw Hill Int. Student Edition
4. James V. Candy - Signal Processing: A Modern Approach, McGraw-Hill, International Edition, 1988.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

SENSORS AND ACTUATORS

(ELECTIVE –III)

UNIT -I:

Sensors / Transducers: Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization

Mechanical and Electromechanical Sensors: Introduction – Resistive Potentiometer – Strain Gauge – Resistance Strain Gauge – Semiconductor Strain Gauges -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors

UNIT –II:

Thermal Sensors: Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors – Acoustic Temperature Sensor – Dielectric Constant and Refractive Index thermosensors – Helium Low Temperature Thermometer – Nuclear Thermometer – Magnetic Thermometer – Resistance Change Type Thermometric Sensors –Thermoemf Sensors– JunctioN Semiconductor Types– Thermal Radiation Sensors –Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors

Magnetic sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors – Anisotropic Magnetoresistive Sensing – Semiconductor Magnetoresistors– Hall Effect and Sensors – Inductance and Eddy Current Sensors– Angular/Rotary Movement Transducers – Synchros – Synchro-resolvers - Eddy Current Sensors – Electromagnetic Flowmeter – Switching Magnetic Sensors SQUID Sensors

UNIT -III:

Radiation Sensors: Introduction – Basic Characteristics – Types of Photosensistors/Photo detectors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors

Electro analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization- – Reference Electrodes - Sensor Electrodes – Electro ceramics in Gas Media .

UNIT -IV:

Smart Sensors: Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation

Sensors –Applications: Introduction – On-board Automobile Sensors (Automotive Sensors)– Home Appliance Sensors – Aerospace Sensors –– Sensors for Manufacturing –Sensors for environmental Monitoring

UNIT -V:

Actuators: Pneumatic and Hydraulic Actuation Systems- Actuation systems – Pneumatic and hydraulic systems - Directional Control valves – Presure control valves – Cylinders - Servo and proportional control valves – Process control valves – Rotary actuators Mechanical Actuation Systems- Types of motion – Kinematic chains – Cams – Gears – Ratchet and pawl – Belt and chain drives – Bearings – Mechanical

aspects of motor selection Electrical Actuation Systems-Electrical systems -Mechanical switches – Solid-state switches Solenoids – D.C. Motors – A.C. motors – Stepper motors

TEXT BOOKS:

1. Sensors and Transducers by D. Patranabis, 2nd edition, PHI Learning Private Limited, 2004.

2 Mechatronics by W. Bolton, 3rd edition, Pearson Education Limited, 2005.

REFERENCE BOOK:

1. Sensors and Actuators by D. Patranabis, 2nd Ed., PHI, 2013.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

DESIGN AND ANALYSIS OF SIGNAL CONDITIONING CIRCUITS

(ELECTIVE-III)

Unit-I:

CLASSIFICATION OF INSTRUMENT TRANSDUCERS

Input characteristics, output characteristics, Electromechanical coupling characteristics-Electromechanical analogies, unified theory of bilateral electromechanical transducers, Basic two-port equations, Ideal transducers, Real transducers, generalized performance analysis of bilateral electromechanical transducers, The transducer constants: Feedback systems.

UNIT-II:

SIGNAL CONDITIONING FOR RESISTIVE SENSORS: measurement of resistance, voltage dividers, Wheatstone bridge. Balance and deflection measurements, sensor bridge calibration and compensation instrumentation amplifiers, interference types and reduction

UNIT-III:

SIGNAL CONDITIONING FOR REACTANCE VARIATION SENSORS: problems and alternatives, ac bridges, carrier amplifiers - application to the LVDT, variable oscillators, resolver-to-digital and digital-to-resolver converters

UNIT-IV:

SIGNAL CONDITIONING FOR SELF-GENERATING SENSORS: chopper and low-drift amplifiers, offset and drifts, amplifiers- electrometer amplifiers, charge amplifiers, noise in amplifiers

UNIT-V:

DIGITAL SENSORS: position encoders, variable frequency sensors - quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, saw sensors, digital flow meters, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, photodiodes and phototransistors, sensors based on MOSFET transistors, charge-coupled sensors - types of CCD imaging sensors, ultrasonicbased sensors, fiber-optic sensors

TEXT BOOKS:

1. Instrument Transducers, An introduction to their performance and design – Hermann K P Neubert. Oxford Publishers, 2nd edition.
2. Sensors and Signal Conditioning: Ramon Pallás Areny, John G. Webster; 2nd edition, John Wiley and Sons, 2000.

REFERENCES:

1. Sensor Technology Handbook – Jon Wilson, Newne 2004.
2. Measurement System: Applications and Design – by E.O. Doeblin, McGraw Hill Publications.
3. Process Control Instrumentation Technology – D. Johnson, John Wiley and Sons.
4. Sensors and Transducers – D.Patranabis, TMH.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

BIOMEMS AND NANOTECHNOLOGY

(ELECTIVE-IV)

UNIT I

Mems and Microsystems : Mems and Microsystems-General principles, advantages, materials used-properties, Technology involved in MEMS. Fabrication techniques- Lithography- etching- Ion implantation-wafer bonding. Integrated processing- Bulk Micro machining- Surface micro machining- coating technology and CVD- LIGA process.

UNIT II

Microsensors and Microactuators : Microsensors and Microactuators –working principle, types- pressure sensors, thermal sensors and actuators, piezoelectric crystals-Intelligent materials and structures, Magnetic sensors and actuators- magnetic materials used for MEMS.

UNIT III

Mems and Microfluidic System : Principle of MOEMS- light modulator, beam splitter, digital micro mirror device, light detectors and optical switch. Micro fluidic System- Fluid actuation method, dielectrophoresis, micro fluid dispenser, micro needle, micro pumps. Application of BioMEMS: Healthcare, drug delivery, micrototal analysis system detection and measurement methods, electronic nose, biochip.

UNIT IV

Introduction to Nanotechnology : Essence of Nanotech, Nanofying electronics, Properties of nanomaterials, metal nano clusters, semiconductor nano particles, nano composites. Introduction to carbon nano structure, carbon molecules, carbon clusters, nanotubesapplication.

UNIT V

Medical Applications of Nanotechnology : Nanotechnology and Biomedicine-Drug synthesis and delivery – Nanobiomedicine and diagnostic-nano fabrication methods-nanomaterials in human body- toxicity in nanomaterials.

TEXT BOOKS:

1. Tai Ram Hsu, “Mems and Microsystems, Design and Manufacture”, McGraw Hill, 2002.
2. Mohamed Gad-el-Hak, “MEMS: Introduction and Fundamentals”, CRC Press, 2005.
3. Neelina H. Malsch, “Biomedical Nanotechnology”, CRC Press, 2005.

REFERENCE BOOKS:

1. Marc J Madou, “Fundamentals of Microfabrication and Nanotechnology”, CRC Press, 2011.
2. Hari Singh Nalwa, “Encylopedia of Nanoscience and Nanotechnology”, American Scientific Publishers, 2004.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

SPEECH PROCESSING

(ELECTIVE IV)

UNIT –I:

Fundamentals of Digital Speech Processing: Anatomy & Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulatory Phonetics, The Acoustic Theory of Speech Production-Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals.

UNIT –II:

Time Domain Models for Speech Processing: Introduction- Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.

UNIT –III:

Linear Predictive Coding (LPC) Analysis: Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, Comparison between the Methods of Solution of the LPC Analysis Equations, Applications of LPC Parameters: Pitch Detection using LPC Parameters, Formant Analysis using LPC Parameters.

UNIT –IV:

Homomorphic Speech Processing: Introduction, Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, The Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, The Homomorphic Vocoder.

Speech Enhancement: Nature of interfering sounds, Speech enhancement techniques: Single Microphone Approach : spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter, Multi microphone Approach.

UNIT-V:

Automatic Speech & Speaker Recognition: Basic pattern recognition approaches, Parametric representation of speech, Evaluating the similarity of speech patterns, Isolated digit Recognition System, Continuous digit Recognition System

Hidden Markov Model (HMM) for Speech: Hidden Markov Model (HMM) for speech recognition, Viterbi algorithm, Training and testing using HMMS.

Speaker Recognition: Recognition techniques, Features that distinguish speakers, Speaker Recognition Systems: Speaker Verification System, Speaker Identification System.

TEXT BOOKS:

1. Digital Processing of Speech Signals - L.R. Rabiner and S. W. Schafer. Pearson Education.
2. Speech Communications: Human & Machine - Douglas O'Shaughnessy, 2nd Ed., Wiley India, 2000.
3. Digital Processing of Speech Signals. L.R Rabinar and R W Jhaung, 1978, Pearson Education.

REFERENCE BOOKS:

1. Discrete Time Speech Signal Processing: Principles and Practice - Thomas F. Quateri, 1st Ed., PE.
2. Speech & Audio Signal Processing- Ben Gold & Nelson Morgan, 1st Ed., Wiley.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

REHABILITATION ENGINEERING

(ELECTIVE-IV)

UNIT I :

Introduction to Rehabilitation Engineering, Principles involved in rehabilitation engineering. Steps in patient management, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability and Functional Diagnosis, Medical Rehabilitation.

UNIT II:

Orthopedic Prosthetics and Orthotics in rehabilitation: Engineering Principles. Prosthesis- Amputation Types Prescribed Prostheses, Components of Upper Limb Prosthesis – Sockets and Liners, Suspension, Control Systems (Myoelectric), Shoulder, Elbow and Wrist components, Terminal Devices. Components of lower limb prosthesis – Sockets and Liners, Suspension, Hip, Pelvic, Knee and Ankle Components. Orthotics-Biomechanical Principles, Spinal, Upper Extremity and Lower Extremity. FES systems-Restoration of hand function, restoration of standing and walking,

UNIT III:

Engineering concepts in sensory rehabilitation Engineering. Sensory augmentation and substitution. Assistive Technology for visually Impaired – General Purpose, Task Specific (Mobility, Reading, Writing, Computer Access, Communication). Assistive Technology for Hearing Impaired – Hearing Assistance Solutions – Medical and Surgical Approach to restore function – Hearing aids, Cochlear Implantation, Assistive Listening Solutions and Visual and Tactual Substitution.

UNIT IV:

Alternative and Augmentative Communication (AAC) - user interface, Language Representation, Technology and Devices Feature. Human Factors, Performance Measurement.

Wheelchairs- Manual, Electric Power, Power Assisted, Multi Functional, Standards, Wheelchairs Transportation System, Securement Systems.

UNIT V:

Rehabilitation Robotics- Intelligent Mobility Aids, Robotics Manipulation Aids, Therapeutic Robots. Environmental Control Systems. Brain Computer Interface.

TEXT BOOKS:

1. Dr. Rory A. Cooper, Hisaichi Ohnabe, Douglas A. Hosbon- An Introduction to Rehabilitation Engineering, CRC Press Book, Taylopr and Francis Group,2007.
2. Horia- Nocholai Teodorecu, L.C.Jain , intelligent systems and technologies in rehabilitation engineering; CRC; December 2000.

REFERENCE BOOKS:

1. Charles J. Robinson “Rehabilitation Engineering”, CRC Press, 1995.
2. Joseph D.Bronzino , “The Biomedical Engineering Handbook” Volume-II, CRC Press 2006
3. G. Salvendy, “Handbook of Human Factors and Ergonomics”, Wiley, 2006.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (BMSP &I)

ADVANCED MEDICAL SIGNAL & IMAGE PROCESSING LAB

LIST OF EXPERIMENTS

NOTE:

- Minimum of 10 Experiments have to be conducted.
- All Simulations are to be carried out using MATLAB/DSP PROCESSORS/LAB VIEW SOFTWARE & DSP KITS.

MEDICAL SIGNAL PROCESSING

a. Least Squares, Orthogonality, and Fourier series
b. Correlation, Fourier Spectra and the Sampling Theorem
c. Linear systems and Transfer Function
d. FIR Filter Design for Biomedical signal processing
e. IIR Filter Design for Biomedical signal processing
f. ECG noise cancellation
g. Biomedical Signal Compression

MEDICAL IMAGE PROCESSING

a. Study of Basic commands in MATLAB
b. Image Linear Filtering and Transforms
c. Image Segmentation
d. Image Restoration techniques
e. Image registration
f. Image Analysis
g. Enhancement and restoration
h. Morphological Operation