तार : विश्वविद्यालय
Gram : UNIVERSITY

टेलीफोन : कार्या0 : 2320496
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बुन्देलखण्ड विश्वविद्यालय, झाँसी
BUNDELKHAND UNIVERSITY, JHANSI

झाँसी (उ.प्र.) 284128

संदर्भ..बु.वि./.....

दिनाँक..19/11/2018

The Minutes of Meeting of BOS

In reference of the BOS of department of .....Biomedical Engineering.....Institute of Institute of Engg. & Tech. held on 19/11/2018 regarding the revision of syllabus in tune with CBCS/NEP-2020 and subsequent approval from Academic Council. This is to certify that the syllabus is 100% revised.

19/11/2018.

HOD/COORDINATOR

Er. Brajendra Shukla
Academic Coordinator
Institute of Engineering And Technology
Bundelkhand University, JHANSI (U.P.)

Institute of Engineering & Technology
Bundelkhand University Jhansi U.P.-284128

Ordinance

For

Undergraduate Degree Program
(B. Tech.)

On

Choice Based Credit System

(Effective from the Session: 2018-19)

Institute of Engineering & Technology
Bundelkhand University Jhansi U.P.-284128.

CHOICE BASED CREDIT SYSTEM (CBCS) ORDINANCE GOVERNING THE DEGREE OF BACHELOR OF TECHNOLOGY (B.Tech.)

CHOICE BASED CREDIT SYSTEM (CBCS):

The choice based credit system provides flexibility in designing curriculum and assigning credits based on the course content and hour of teaching. The choice based credit system provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective and open elective courses .The CBCS provides a cafeteria type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquired more than the required credits, and adopt an interdisciplinary approach to learning. The courses shall be evaluated on the grading system, which is considered to be better than the conventional marks system. It is necessary to introduce the grading system to make the uniformity among all technical institutions of India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the AICTE has formulated the guidelines to be followed.

DEFINITIONS OF KEY WORDS:

(i) University: Bundelkhand University Jhansi U.P. 284128

(ii) Academic Year: Two consecutive (one odd + one even) semesters constitute one academic year.

(iii) Semester: Each semester will consist of 15-20 weeks of academic work equivalent to 90 actual working days. The odd semester may be scheduled from July to December and even semester from January to June.

(iv) Choice Based Credit System (CBCS): The CBCS provides choice for students to select from the prescribed courses *(core, elective and Foundation Courses etc).*

(v) Credit Based Semester System (CBSS): Under the CBSS, the requirement for awarding a degree is prescribed in terms of number of credits to be earned by the students.

(vi) Programme: B.Tech. educational programme leading to award of a Technical Degree.

(vii) Course: Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same weightage. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study etc. or a combination of some of these.

(viii) Branch: discipline of B.Tech. Degree Programme (Biotechnology Engineering/Biomedical Engineering /Computer Science & Engineering/Electronics & Communication Engineering /Electronics & Instrumentation Engineering / Food Technology /Mechanical Engineering)

(ix) Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters A,B,C ,D,E and F

(x) Grade Point: It is a numerical weightage allotted to each letter grade on a 10-point scale.

(xi) Credit: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.

(xii) Credit Point: It is the product of grade point and number of credits for a course.

(xiii) Semester Grade Point Average (SGPA): It is a measure of academic performance of student/s in a semester. It is the ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed as round off to two decimal places.

(xiv) Yearly Grade Point Average (YGPA): It is a measure of academic performance of student/s at the end of the academic year. The formula used to calculate YGPA is given in section 14.4 (b). It shall be expressed up to two decimal places.

(xv) Cumulative Grade Point Average (CGPA): It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points earned by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed as round off to two decimal places.

(xvi) Transcript or Grade Card or Certificate: Based on the grades earned, a grade sheet/certificate shall be issued on demand to the registered student at the end of every academic year. The grade sheet/certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of both semesters and CGPA earned till that academic year.

1. ADMISSION

Admission to B.Tech first year in I semester and lateral admission in B.Tech. II year will be made as per the rules prescribed by the Academic Council of the Bundelkhand University Jhansi.

ELIGIBILITY FOR ADMISSIONS

(a) Admission to B. Tech. First Year as per Bundelkhand University Norms which is generally based on AICTE and according to the latest U.P. Government notifications/rules.

S.No.	Branch	Approved Seats	Eligibility Criteria for admission
1.	B.Tech.(Biotechnology Engineering)	60	10+2 with Physics, Chemistry, Biology/Mathematics/Biotechnology with minimum 50% marks in aggregate
2	B.Tech. (FoodTechnology)	60	
3.	B.Tech.(Biomedical Engineering)	60	10+2 with Physics ,Chemistry and Mathematics with minimum 50% marks in aggregate
4.	B.Tech. (Computer Science & Engineering)	60	
5.	B.Tech. (Electronics & Communication)	60	
6.	B.Tech. (Electronics & Instrumentation Engineering	60	
7.	B.Tech. (Mechanical Engineering)	60	

(b) Admission to B. Tech. Second Year through Lateral Entry Scheme:

Candidates who have passed 3/4 year Diploma (with minimum 60% marks) from institutions recognized by the U.P. Board of Technical Education in any branch of Engineering/Technology are eligible for admission to Second year in any branch of Engineering./Technology.

Note: Relaxation in marks for reserved category candidates in eligibility will be provided as per latest AICTE/U.P. Government norms/notifications/rules.

2. DURATION OF COURSES

2.1 Minimum duration of the B.Tech. course shall be four (04) years.

2.2 The student admitted to B.Tech First year shall complete the course within a period of Eight (08) academic years from the date of first admission, failing which he/she has to discontinue the course.

2.3 The student admitted to lateral entry scheme (2nd year B.Tech.) shall complete the course within a period of six academic years from the date of first admission, failing which he/she has to discontinue the course.

3. CURRICULUM

The 4 year curriculum has been divided into 8 semesters and shall include lectures, tutorials, practicals, seminars and projects etc. in addition to industrial training and educational tour etc. as defined in the scheme and executive instructions issued by the University from time to time.

The curriculum will also include such other curricular, co -curricular and extracurricular activities as may be prescribed by the University from time to time.

There will be four types of courses.

(i) Foundation Courses (Basic science / Engineering science / Humanities / Social science): The Foundation Courses are of two kinds: *Compulsory Foundation* and *Elective foundation*.

"Compulsory Foundation": These courses are the courses based upon the content that leads to Knowledge enhancement. They are mandatory for all disciplines.

"Foundation Electives": These are value based courses aimed at man making education.

(ii) Core Courses: This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirements of a program in a said discipline of study.

(iii) Elective Courses: This is course, which can be chosen from the pool of papers. It may be supportive to the discipline/ providing extended scope/enabling an exposure to some other discipline / domain / nurturing student proficiency skills.

(iv) Mandatory Courses: These courses are mandatory for students joining B.Tech. Program and students have to successfully complete these courses before the completion of degree.

4. CHANGE OF BRANCH

Change of branch may be allowed against the vacant seats in the second year, on the basis of merit at the B.Tech. First year examination for those who are passing without any carry over paper. The change of branch if allowed will become effective from B.Tech. IIIrd semester.

5. EXAMINATION

5.1 Attendance: Every student is required to attend all the lectures, tutorials, practicals and other prescribed curricular and co-curricular activities. The attendance can be condoned up to 25% on medical grounds or for other genuine reasons beyond the control of students, of which 10% can be condoned by Coordinator/Head of the Department and further 15% by Dean/Director of the institute. A further relaxation of attendance up to 15% for a student can be given by Hon'ble Vice Chancellor of the university on recommendation of the Coordinator/Head of the Department/Dean/Director for the reasons acceptable to him.

5.2 The performance of a student in a semester shall be evaluated through continuous class assessment and end semester examination. The continuous assessment shall be based on class tests, assignments/tutorials, quizzes/viva-voce and attendance. The marks for continuous assessment (Sessional marks) shall be awarded at the end of the semester. The end semester examination shall be comprised of written papers, practicals and viva-voce, inspection of certified course work in classes and laboratories, project work, design reports or by means of any combination of these methods. There shall be two class tests/sessional tests for theory subjects as well as for practicals of equal weightage. Improvement/Make-up test shall be held for those students who want to improve their performance or who could not appear in any one of class tests/sessional tests due to genuine reasons for which the prior permission from the Dean/Director of the institute was taken. The syllabus for the make-up test shall be the whole syllabus covered by the subject teacher upto that time.

5.3 Semester Examination shall be conducted by the University in accordance with the Academic Calendar of the University. The performance of a student in a semester shall be

evaluated through continuous class assessment and semester examination as prescribed by BO in concerned course program. The continuous assessment shall be based on class tests, assignmen / tutorials and viva-voce. The marks for continuous assessment (internal / sessional marks shall be awarded at the end of the semester. The semester examination shall comprise o written papers, practical and viva-voce, internal / sessional, inspection of certified course wor in classes and laboratories, project work, design reports or by means of any combination of thes methods, as applicable. The examiners (internal and internal) for the theory and practical o semester should be approved by Hon'ble vice chancellor based on the list of panel proposed by BOS/HOD.

5.4 The range of total credit requirement for B.Tech. degree is 150-160. The distribution of marks and credits for internal / sessional, theory papers, practical and other examinations, seminar project and industrial training and shall be as prescribed in the respective course structure and syllabus recommended by B.O.S. The practical, viva-voce, projects and reports shall be examined/evaluated through internal and external examiners as and when required.

5.5 Each academic year shall consist of two semesters and semester examination shall be held at the end of each semester. In case a student fails in any paper / subject, he or she shall appear as back paper in the odd / even semester examination to clear that paper / subject.

5.6 If a student has not appeared in final semester examination he / she shall be required to appear in the next regular examination with the next batch on payment of a fee as per the University rules. There shall be no provision of special back paper examination in the course program of CBCS for first to third year students. The special back paper will be conducted after the result of final semester of the course program.

5.7 Students who have failed in Internal / Sessional / Practical examination shall be allowed to reappear with the next batch on payment of the fee as per the University rules.

5.8 The University shall conduct special back paper examination in the month of September every year (after the final result of the course is declared).

5.9 In case of year back students, marks obtained in Internal / Sessional / Practical examination shall carry forward.

6. ELIGIBILITY OF PASSING

The Bundelkhand University has adopted by enlarge the UGC prescribed grade system. At the end of each semester, the performance of students shall be evaluated in terms of marks which shall be converted into letter grades as per the following equivalent grade points in table -1 as mentioned by UGC for CBCS system.

Letter Grade	Numerical grade
O (outstanding)	10
A+ (Excellent)	9
A(very good)	8
B+(Good)	7
B(Above average)	6
C(Average)	5
F(Fail)	0
Ab (Absent)	0

The minimum passing marks shall be 40% of the maximum marks as prescribed in the University Examination and 40% of marks in the aggregate marks in the subject including internal / sessional marks. i.e. Minimum Passing Grade is "C".

A student who obtains Grades O to C shall be considered as passed. If a student secures "F" grade, he /she shall be considered as FAIL and shall have to reappear in the examination. It is mandatory for a student to earn the required SGPA as in each semester. If a student is not able to secure 40%/ C grade in any theory / practical / internal / sessional / viva-voce / internship / project examination, the awarded grade point shall be ZERO (0).

A student shall be considered to have passed in a COURSE only if he/she secures a minimum of 40% in theory papers / practical / internal / sessional / internship / project / viva-voce separately i.e. the minimum passing grade is "C".

CGPA must be greater than or equal to 5.0.

7. ELIGIBILITY FOR PROMOTION

There shall be no restriction for promotion from an odd semester to the next even semester. In every even semester result will be prepared on the basis of YGPA.

A student to be promoted to the next academic year he/she shall have (i) to pass at least 50% of the total number of theory papers (the foundation papers will not be included) at the end of the first two semesters, which means that a student shall have to secure a "C" grade (at least 40 % marks) in fifty percent of the total number of papers of the two semesters taken together(core and elective) and (ii) to secure at least 30% marks/03 YGPA with 03 Grade Point at the end of the two semesters of an academic year for promotion to the next year.

In case a student fails in an academic year his/her sessional marks/educational tour marks/ practical marks /project report/viva-voce marks shall carry forward.

Provided that such student who secure 40% in all papers of a semester but unable to secure the minimum 50% in grand total of two semester of a academic session such student be permitted to appear in back paper to secure 50% marks(Grade C) for passing the semester.

Student will have to obtain at least 'C' grade in SGPA but YGPA there should be at least 3.0 YGPA.

8. BACK PAPER

If a paper (Internal/Theory/Practical) or subject is not clear in first attempt and student has promoted to next academic year via rule 5.2 then he/she shall be permitted to appear in the examination in failed subject with subsequent semester (i.e. odd semester exam will be given with odd semester and even will be given in even semester).

The special back paper shall be conducted after the final examination result of last semester of the course program. The University shall conduct special back paper examination in the month of September every year. The failed student can be given a chance to appear in special back paper examination. If any student further fails to pass in any paper, no further special back will be allowed. Such student will have to appear in subsequent (odd/even) semester examination only up to course duration as mentioned in clause 2.2.

9. IMPROVEMENT IN GRADE

A Student can only appear for improvement in theory subject / paper of previous academic year (paper of odd subject / paper with odd semester and paper of even subject / paper with even semester), if he / she is passed in all papers of previous year. There shall be no provision for organizing a special examination for the purpose of improvement in grade.

10. COMPUTATION OF SGPA, YGPA AND CGPA

The Bundelkhand University, adopts absolute grading system wherein the marks are converted grades, and every semester results will be declared with semester grade point average (SGPA) a year result will be declared with year grade point average (YGPA). The Cumulative Grade Poi Average (CGPA) will be calculated in end of final semester. The grading system will be wi following letter grades and grade points scale as given below:

Level	Outstanding	Excellent	Very Good	Good	Above Average	Average	Fail
Letter Grade	O	A+	A	B+	B	C	F
Grade Points	10	9	8	7	6	5	0
Score (Marks) Range (%)	≥ 90 (90-100)	<90, ≥80 (80-89.99)	<80, ≥70 (70-79.99)	<70, ≥60 (60-69.99)	<60, ≥50 (50-59.99)	<50, ≥40 (40-49.99)	< 40 (0-39)

A student obtaining Grade "F" shall be considered failed and will be required to reappear in th examination. Such students after passing the failed subject in subsequent examination/s will b awarded with grade respective of marks he/she scores in the subsequent examination/s.

The University has the right to scale/moderate the theory exam / practical exam / internal exam sessional marks of any subject whenever required for converting of marks in to letter grades on th basis of the result statistics of university as in usual practice, i.e. marks obtained in decimal will b converted in nearest integer.

The following procedure to compute the Semester Grade Point Average (SGPA), Yearly Grade Point Average (YGPA) and Cumulative Grade Point Average (CGPA):

(a) The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e SGPA (Si) = Σ (Ci x Gi) / ΣCi where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

(b) The YGPA(Yearly Grade Point Average) is calculated at end of each year as:

$$YGPA = (SGPA_{(odd)} * \Sigma C_{i(odd)} + SGPA_{(even)} * \Sigma C_{i(even)} / (\Sigma C_{i(odd)} + \Sigma C_{i(even)})$$

(c) The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e. CGPA = Σ (Ci x Si) / Σ Ci where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

(d) The SGPA shall be calculated at end of each semester and YGPA shall be calculated at the end of each academic year. CGPA shall be calculated at the end of last semester of the Program and shall be rounded off to 2 decimal places and reported in the transcripts / grade Sheet.

ILLUSTRATION : I[st] Semester without back

S.No.	Course	Credit	Grade Letter	Grade Point	Credit Point
1	*MA-202/ 1856	3	A	8	24
2	1863/ HU-101	2	B	6	12
3	1857/ PH-201	2	B+	7	14
4.	1859/ ME-201	3	O	10	30
5.	1861/ CS-201	3	C	5	15
6.	1865/CE-201	3	B	6	18
PRACTICAL/TRAINING/PROJECT					
7.	10874/ HU-251	1	A	8	8
8.	10870/ CS-251	1	B	6	6
9.	10872/ CE-251	1	B+	7	7
10	10868/ME-251	1	O	10	10
		20			144

SGPA = 144/20 = 7.2

I[st] semester with back in one paper

In case the candidates fails in one subject then his subsequent SGPA calculation

S.No.	Course	Credit	Grade Letter	Grade Point	Credit Point
1.	*MA-202/ 1856	3	A	8	24
2.	1863/ HU-101	2	B	6	12
3.	1857/ PH-201	2	B+	7	14
4.	1859/ ME-201	3	O	10	30
5.	1861/ CS-201	3	F	0	0
6.	1865/CE-201	3	B	6	18
PRACTICAL/TRAINING/PROJECT					
7.	10874/ HU-251	1	A	8	8
8.	10870/ CS-251	1	B	6	6
9.	10872/ CE-251	1	B+	7	7
10	10868/ME-251	1	O	10	10
		20			129

SGPA = 129/20 = 6.45

In the subsequent attempt suppose the candidate obtained grade E then calculation will go as follows

Course	Credit	Grade Letter	Grade Point	Credit point
1861/CS 201	3	C	5	3x4 = 15

Ci (First Attempt) i.e. 129 + Ci (subsequent attempt) i.e. 15 = 144 Thus, SGPA= 144/20=7.2

II[nd] SEMESTER

	Course	Credit	Grade Letter	Grade Point	Credit Point
1.	*MA-202/ 1856	3	A	8	24
2.	1863/ HU-101	3	B	6	18
3.	1857/ PH-201	2	B·	7	14
4.	1859/ ME-201	3	O	10	30
5.	1861/ CS-201	3	A⁺	9	27
6.	1865/CE-201	0	-	-	-
PRACTICAL/TRAINING/PROJECT					
7.	20316	1	A	8	8
8.	20317	1	B	6	6
9.	20318	1	B·	7	7
10.	20319	1	O	10	10
		18			144

Thus, SGPA= 144/18=8.0

YGPA= (SGPA(odd) * ΣCi(odd)+ SGPA(even) * ΣCi(even) / (ΣCi(odd) + ΣCi(even))

YGPA = (7.2*20+8.0*18)/(20+18) = 7.58

Credit After Final Semester

SEM 1	SEM 2	SEM 3	SEM 4	SEM 5	SEM 6	SEM 7	SEM 8
Credit :20	Credit :18	Credit :21	Credit :21	Credit :21	Credit :21	Credit :19	Credit :19
SGPA:7.2	SGPA:8.0	SGPA:8.1	SGPA:7.34	SGPA:9.1	SGPA:6.38	SGPA:7.34	SGPA:7.9

Thus CGPA =

$$\frac{20 \times 7.2 + 18 \times 8 + 21 \times 8.1 + 21 \times 7.34 + 21 \times 9.1 + 21 \times 6.38 + 19 \times 7.34 + 19 \times 7.9}{160}$$

⇨ CGPA = 7.668

⇨ CGPA = 7.67 (Round of to two decimal places)

Grade sheet: Based on the above recommendations on Letter grades, grade points, SGPA of each semester and YGPA of an academic year, a consolidated grade sheet indicating performance in a particular academic year.

CGPA (calculated at the end of the last semester of the program) shall be issued.

11. CONVERSION OF GRADES INTO PERCENTAGE

Conversion formula for the conversion of CGPA into Percentage is **CGPA Earned x 10 = Percentage of marks scored.**

Illustration: CGPA Earned 8.2 x 10 = 82.0%

12. AWARD OF DIVISION

Division shall be awarded only after the final semester examination based on integrated performance of the student for all the semesters as per following details.

A student who qualifies for the award of the degree securing "C" or above grades in all subjects pertaining to all semesters, and in addition secures a CGPA of 7.5 and above shall be declared to have passed the examination in **FIRST DIVISION WITH HONOURS.**

A student who qualifies for the award of the degree securing "C" or above grades in all subjects pertaining to all semesters, and in addition secures a CGPA less than 7.5 and greater than or equal to 6.0 shall be declared to have passed the examination in **FIRST DIVISION.**

A student who qualifies for the award of the degree securing "C" or above grades in all subjects pertaining to all semesters, and in addition secures a CGPA less than 6.0 and greater than or equal to 5.0 shall be declared to have passed the examination in **SECOND DIVISION.**

13. CANCELLATION OF ADMISSION

The admission of a student at any stage of study shall be cancelled if:

(a) He / She is not found qualified as per AICTE / State Government norms and guidelines or the eligibility criteria prescribed by the University or

(b) He / She is found unable to complete the course within the stipulated time or

(c) He / She is found involved in creating indiscipline in the Institution or in the University.

Note: The University Academic Council shall have the power to amend/change any clause of ordinance of the Institute of Engineering & Technology.

3/12/18 (Er. Brajendra Shukla) (Ar. Zakir Ali) (Er. VIJAY Kr. VERMA)

3/12/18 (Awadhesh Gaur) 3.12.18 (Ikram Verma) (Er. Ravi Kumar)

CBCS/Ordinance Committee Members

3/12/18 (Er. Lakhan Singh) (Er. B.B. Niranjan) (Shubhangi)

Coordinators/Internal Members

Experts

Dean/Director

Institute of Engineering and Technology

List of value added courses-

Note-

SEM -I	**SEM-II**
Photography	Cyber security & ethical hacking
Google Ads	Digital marketing
Goal Setting	Bio-CNG (Green Fuel)
SEM-III	**SEM-IV**
IELTS | IID	E- waste recycling business
Mushroom Cultivation Business	Advance Excel
Introduction to MATLAB	Mobile App Development
SEM-V	**SEM-VI**
Internet of things (IOT)	Marketing Content Writer
Bakery Technology	Milk Processing Business
Drone technology	Organic Waste Management

- ✓ The Students have to choose any one value added course in each semester from the list.
- ✓ The course will be of non - evaluative and non – credit in nature
- ✓ Each value-added course shall be of 30 hrs.

Vision & Mission of the Institute (IET)

Vision of Institute:

To emerge as an institution of excellence in engineering education and research that emphasizes on the human values, competence and professionalism integrated with the course curriculum as per global standards to serve the nation as well as the society with innovating mindset to take up any challenge they come across in industrial, scientific or academic fields within or outside the country.

Mission of Institute:

M1	To equip with the latest tools and equipment matching the state-of-art technologies to facilitate the academic and research activities at par with the best institutions.
M2	To inculcate a proper mix of creativity, innovation, competence, entrepreneurial leadership, and professionalism in the minds of the students so as to yield the internationally accepted best products.
M3	To provide proper ambiance for the teaching-learning system that preserves Universal human values, ethics, and morals to meet the aspirations of all the stake holders for sustainable development of the institute.
M4	To develop a potential pool of intellectuals and professionals that can serve any where efficiently in decision making and policy adoption according to the local, National and global needs.

Vision & Mission of the Department (BME)

Vision of BME Department

The Department of Biomedical Engineering's **vision** is to be the premier biomedical engineering platform in the world, based on the excellence of our people, our innovative multidisciplinary and enabling research, and our discovery-centered educational programs. We strive to pioneer the transfer of biomedical engineering research into applications that will advance and improve health care throughout Texas and the world.

Mission of Department

M1	To impart the students with the right theoretical and practical knowledge of as well Medical Electronics as well as Biomedical Engineering.
M2	To develop clinically translatable solutions for human health by training the next generation of biomedical engineers, cultivating leaders, and nurturing the integration of science, engineering, and medicine in a discovery-centered environment.
M3	To provide proper ambiance for effective interactions of students, faculty and management with the Hospital/ Biomedical Engineering industry personnel, alumni, academicians of premier Institutions and other stake holders for sustainable development of the department and its stake holders.
M4	To inculcate entrepreneurship and human values & ethics in the students for sustainable development of the society and the Biomedical Engineering community.

PROGRAM OUTCOMES (PO) for IET

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review and analyze complex engineering problems from the research papers and literature, and there after reach substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate cultural, societal, and environmental considerations for public health and safety.

PO4: Conduct investigations of complex problems: Use research-based knowledge and methods including design of experiments, analysis, and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply to reason informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams and individual and in multidisciplinary settings relevant to the professional engineering practice.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering 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.

PO12:Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PROGRAM OUTCOMES (PO) for BME Dept.

On completion of the B. Tech degree the Biomedical Engineering, the graduates will be able to:

PO1: Engineering knowledge: - Apply the knowledge of mathematics, biology, science, engineering fundamentals, and an engineering specialization to the solution of complex Medical / Hospital Instruments & Engineering problems.

PO2: Problem analysis: - Identify, formulate, review research literature, and analyze complex medical instruments & engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, Bioscience and engineering sciences.

PO3: Design/development of solutions: - Design solutions for complex Biomedical Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health Diagnosis and Therapeutic safety, and the Medical /Hospital, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: - Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: - Create, select, and apply appropriate Biomedical Instrumental techniques, resources, and modern engineering and IT tools including prediction and modeling to complex Bioengineering activities with an understanding of the limitations.

PO6: The engineer and society: - Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and Biological, Medical/ Hospital technological issues and the consequent responsibilities relevant to the professional Biomedical engineering practice.

PO7: Environment and sustainability: - Understand the impact of the professional Biomedical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: - Apply ethical principles and commit to professional ethics and responsibilities and norms of the Biomedical engineering practice.

PO9: Individual and team work: - Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: - Communicate effectively on complex Biomedical engineering activities with the Bioengineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: - Demonstrate knowledge and understanding of the engineering 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.

PO12:Life-long learning: - Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological changes in the field of Biomedical Engineering.

PROGRAM SPECIFIC OUTCOMES (PSO) for BME Dept.

On completion of the B. Tech degree the Biomedical Engineering, the graduates will be able to attain the following program specific attributes in addition to 12 PO's mentioned:

PSO-1: Graduates of the program will be able to analyze real world engineering problems and able to design its solutions in the field of Biomedical engineering.

PSO-2: Graduates of the program will be able to design and develop systems/processes based on core concepts of Biomedical engineering to provide solution to multidisciplinary Medical / Hospital Instruments & engineering problems.

PROGRAM EDUCATIONAL OBJECTIVES (PEO) for BME Dept.

PEO-1: Engineering Graduates must be experts in Medical/Hospital Instrument fields both in the industry and academics by analyzing the requirement of society and applying their knowledge in a professional manner.

PEO-2: Engineering graduates must be able to effectively solve engineering problems and develop products through advanced research in Biomedical Engineering.

PEO-3: Engineering graduates must be capable of applying their knowledge both individually and as a part of a team and they must be able to effectively present the same through the required media.

PEO-4: Engineering Graduates must be capable of realizing the unwanted and hazardous impacts of their contributions and keep ethical and societal values and responsibilities before individual achievements.

PEO-5: Engineering Graduates must keep pace with the ongoing improvements and advancements in the field of Biomedical Engineering and not only incorporate but carry forward the same for entrepreneurship development.

Course Title	**FUNDAMENTALS OF ELECTRONIC DEVICES**				
Course code	**BM-301/ 2371**				
Category	Professional Course				
Scheme and Credits	L	T	P	C	Semester III
	3	1	0	4	
Pre-requisites(if any)	None. Desirable– Knowledge of Semiconductor Physics				
Course Objectives	The objective of this course is to impart • To expose the students to Fundamentals Semiconductor Physics • To understand the Energy bands in PN Junction, BJT, FET and Electrical Characteristics. • To learn the Opto Electronic Devices, Quantum Mechanics, Tunneling, • To learn Types of Microwave Devices, Transit Time, Transferred Electron Devices • To Understand operation Power Electronic Devices				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Understanding Crystal Properties, Energy band Formations, Semiconductor Physics and Calculations of parameters associated with Semiconductors.	Introducing, Evaluating
CO2	Understanding Concept of Excess Charge, Diffusion, Carrier Lifetime Continuity Equation and Develop Diode Equation	Understanding
CO3	Understanding Formation of PN Junctions its properties and variations in Energy Bands with Biasing.	Understanding
CO4	Apply the Concepts to Understand Types of Transistors BJT, MISFET, and MESFET.	Applying
CO5	Understanding the Concept of Opto-Electronic Devices and Power Electronic Devices.	Understanding
CO6	Types Microwave Devices Tunnel Diode, Schottky Junction, Transit Time Devices, Transferred Electron Devices	Understanding

Detailed Contents Fundamentals of Electronic Devices BM-301/ 2371			
Modules	**Contents**	**L (Hours)**	**T (Hours)**
I	**Crystal Properties and charge Carriers in Semiconductors:** Elemental and compound carriers in semiconductors, carrier concentrations, drift of carriers in electric and magnetic fields.	9	-
II	**Excess Carriers in Semiconductors**: Optical absorption, luminescence, carrier life time and photo conductivity, diffusion of carriers.	7	-
III	**Junction Properties:** Equilibrium conditions, biased junctions, steady state conditions, reverse bias break down, transient and AC conditions .Metal semiconductor junctions.	9	-
IV	**Transistors:** Metal semi conductor-field-effect-transistors (MESFET), Metal-insulator-semiconductor-field-effect-transistors (MISFET), Metal oxide semiconductor field effect transistor (MOSFET): Construction, Operation and characteristics of above devices. Bipolar junction transistors: Fundamentals of BJT operation, amplification with BJTs,	10	-
V	**Some special devices**: Photodiodes, photo detectors, solar cell, light emitting diodes, semiconductor lasers, and light emitting materials. Tunnel Diode: degenerate semiconductors.IMPATT diode; the transferred electron mechanism: The GUNN diode. P-NP-N diode, semiconductor controlled rectifier (SCR), bilateral devices: DIAC, TRIAC, IGBT	12	-
	Total	**47**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	B. G. Streetman and S. Banerjee	"Solid state electronics devices", 5th Edition, PHI.
2	S. M. SZE, KWOK K NG	"Physics of Semiconductor" Devices, 3rd Edition WILEY Publications
3	MillMan, Halkias	"Integrated Electronics", McGraw Hill Electrical and Electronic Engineering Series
4	Donald A Neamen	"Semiconductor Phuysics and Devices",4th Edition, Mc Graw Hill (Indian Edition)

Electronics materials, Web Site, etc: www.nptel.ac.in

Course Title	**HUMAN ANATOMY AND PHYSIOLOGY**				
Course code	**BM-302/2372**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester III
	3	1	0	4	
Pre-requisites(if any)	None. Skeletal .				
Course Objectives	• The primary goal of Biomedical Science is ***to*** *enhance understanding of human body function in health and disease.* • Human anatomy is the study of the structures of the human body. An understanding of anatomy is key to the practice of medicine and other areas of health. • To explain the anatomy, physiology and functions of various Tissues and cell, organization of cellular system. • Classify different types of tissue and explain anatomy and physiology of skeletal system and joints • To explain the anatomy and Physiology of digestive, nervous, urinary and reproductive system, Anatomy and Physiology of endocrine system, sense organs and Physiology of muscle contraction and its disorders				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Learn Anatomy and Physiology and basic terminologies.	Understanding
CO2	Learn the gross morphology, structure and functions of various organs of the human body.	Understanding
CO3	Learn the various homeostatic mechanisms and their imbalances.	Applying
CO4	Know to Identify the various tissues and organs of different systems of human body.	Evaluating
CO5	Perform the various experiments related to special senses and nervous system.	Evaluating
CO6	Appreciate coordinated working pattern of different organs of each system	Understanding

Detailed Contents	**HUMAN ANATOMY AND PHYSIOLOGY BM-302/2372**		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Basic cell structure, various cell organelles and their functions. Tissue, their types structures and functions, Structure and functions of skin. Different types of muscles and their function. General description of types of bones, structure and function of bones. General description of types of joints, structure and functions.	9	-
II	Blood, lymph and circulation – composition of Blood ,properties, structure and functions of red blood cells, white blood cells and platelets, Blood types, heamolysis, immune mechanism. Heart positin,structure and functions. Origen of heart beat and activity of the heart artries, cappliries and vessels-Structure and functions. Cardiac and peripheral circulation. Blood flow and it's regulation, dynamics of lymph flow.	10	-
III	Respiratory system, positin, structure and functions. Mechanics of respiration. Lungs volume and capacities. Gas transport between the lungs and tissues. Regulation of respiration. Respiratory adjustment in health and diseases. Digestive system: parts of the digestive system, structure and functions of these organs. Digestion of protein, carbohydrates,fats. Vitamins and minerals	10	-
IV	Renal system: parts of the renal system- kidney, ureter, urinary bladder and urethra. structure and functions of the system. Formation and composition of urine. Endocrine system and reproductive system: elementary knowledge of structure and function of endocrine glands. Functions of male reproductive organs, female reproductive organs and contraception.	10	-
V	Nervous system and special senses: basic structure and function of central nervous system. Receptor, neurons, synapse and reflexes. Ventrical and cerebrospinal fluid. Autonomic nervous system Structure of sensory organs: Eye, Ear, tongue, nose and skin. Mechanism of vision, color vision, mechanism of hearing and tastes Physiology of olfaction and smell.	9	-
	Total	**48**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	Ross and Wilson (ELBS pub)	Anatomy and physiology in Health and illness
2	William Ganong (Prentice Hall Int)	Review of medical physiology
3	Physiology of Human Body	Guyten (Prism Books

Course Title	**FUNDAMENTALS OF NETWORK ANALYSIS AND SYNTHESIS**				
Course code	**BM-303/ 2373**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester III
	3	0	0	3	
Pre-requisites (if any)	None. Desirable– Knowledge of basic electrical theorems				
Course Objectives	The objective of this course is to impart • To develop an understanding of the fundamental laws and elements of electrical circuits. • To learn the energy properties of electric elements and the techniques to measure voltage and current.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Understand the basic electrical circuits with nodal and mesh analysis. Study of steady state and transient analysis.	Understanding
CO2	Description of various network theorems. Apply Laplace transform for circuit analysis.	Analysis
CO3	Description of two port network and its parameters.	Understanding
CO4	Description of different network functions.	Analysis
CO5	Description and synthesis of various networks.	Evaluating

Detailed Contents	**Fundamentals of Network Analysis and Synthesis BM-303/ 2373**		
Modules	**Contents**	**L (Hours)**	**T (Hours)**
I	Signal analysis, complex frequency, network analysis, network synthesis General characteristics and descriptions of signals, step function and associated wave forms, The unit impulse Introduction to network analysis, network elements, initial and final conditions, step and impulse response, solution of network equations.	10	-
II	Review of Laplace transforms poles and zeroes, initial and final value theorems, the transform circuit, Thevenin's and Norton's theorems, the system function, step and impulse responses, the convolution integral. Amplitude and phase responses. Network functions, relation between port parameters, transfer functions using two port parameters, interconnection of two ports.	10	-
III	Hurwitz polynomials, positive real functions. Properties of real immittance functions, synthesis of LC driving point immittances, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances.	10	-
IV	Properties of transfer functions, zeroes of transmission, synthesis of Y21 and Z21 with 1 ohm termination.	9	-
V	Introduction to active network synthesis	8	-
	Total	**47**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	M. E. Van Valkenberg	"Network Analysis", 2nd Edition, Prentice Hall of India Ltd
2	Charles Alexander and Sadiku Mathew	Fundamental of Electric circuit
3	D. Roy Chowdhary	Network and Systems

Course Title	**ELECTRONICS MEASUREMENT AND INSTRUMENTATION**				
Course code	**BM-304/2374**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester III
	3	0	0	3	
Pre-requisites(if any)	Basic Electronics Engineering				
Course Objectives	The objective of this course is • To know the necessity of different measuring instruments and their design principle. • To understand the working principle of different measuring instruments. • To learn the architecture and working principle of advanced measuring instrument and their applications.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Understand the principle and working of various analog Electromechanical instruments and to design the instruments for extension in instruments range.	Understanding & Analyzing
CO2	Manifest the working of instruments like electronic voltmeter and ammeter, series ohmmeter, multi-meter, frequency meter.	Understanding
CO3	Analyze the bridges for the measurement of resistance, capacitance and inductance.	Analyzing
CO4	Understand the principle and working of various waveform generators, analyzers and display devices and analyze the phase and frequency by Lissajous pattern.	Analyzing
CO5	Demonstrate the working of instrument transformers.	Understanding

Detailed Contents	**Electronics Measurement and Instrumentation BM-304/2374**		
Modules	**Contents**	**L(Hours)**	**T (Hours)**
I	**Analog Measuring Instruments:** Classification of analog instruments, operating forces in indicating instruments, T/W ratio, pointers and scales. Working principle, theory, construction and salient features of electromechanical indicating / registering instrument viz. PMMC, Electrodynamometer, Moving iron, Rectifier type, Induction type for the measurement of dc and ac voltage, current, power, energy (1 -phase induction type wattmeter), power factor (single phase Electrodynamometer).	10	-
II	**Ammeter, Voltmeter and Ohmmeter**: galvanometer, DC ammeter, DC voltmeter, series ohm meter, AC electronic voltmeter, current measurement with electronic instruments, multi meter probes, digital multi meters.	8	-
III	**Measurement of Resistances:** Classification of resistances, measurement of medium resistance, Measurement of low resistance (Kelvin double bridge, Ammeter - Voltmeter) and Measurement of high resistance including loss of charge method and Mega ohm bridge method. **AC Bridges:** General theory of ac bridge, Measurement of self inductance, Measurement of capacitance, Measurement of mutual inductance, Measurement of frequency, Sources of error in ac bridges and their minimization.	10	-
IV	**Instrument Transformers:** Theory and construction of current and potential transformers, transformation ratio and phase angle errors and their minimization, effects of pf, secondary burden and frequency.	8	-
V	**Cathode Ray Oscilloscope:** Principle and working of CRO, Block diagram presentation of CRO and brief description of various elements of CRO – CRT, horizontal Deflecting system, Vertical deflecting system, CRO screen, Measurement of voltage, frequency and phase angle using CRO, CRO probes, DSO ,DSO Probe,Wave analyzer.	9	-
	Total	**45**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	A K Sawhney	Electrical and Electronics Measurements and Instrumentation,19th Edition,(2016)
2	H S Kalsi	Electronics Instrumentation and Measurements, 4th edition(March 2019)
3	Devid A Bell	Electronic Instrumentation and Measurements", Prentice Hall, Inc, New Delhi (2013)
4	W D Cooper	Electronic Instrumentation and Measurement Techniques", Prentice Hall, New Delhi ,2nd Edition

Electronics materials, Web Site, etc: https://onlinecourses.nptel.ac.in

Course Title	**BIOMEDICAL STATISTICS**				
Course code	BM-305 /2375				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester -III
	3	0	0	3	
Pre-requisites (if any)	None Fundamental knowledge of Biomedical Statistics				
Course Objectives	The objective of this course is to learn about biomedical data analysis using mathematical modelling, statistics, and machine learning.				

Course Outcomes

On successful completion of this course students will be able to

CO1	Review the major sources of data on mortality, morbidity and health in other developed regions in order to examine their potential for analysing mortality and morbidity levels and trends.	Analyzing
CO2	Define and calculate mean, median, mode, and range. Construct data tables that facilitate the calculation of mean, median, mode, and range. Determine which measure of central tendency is best to use in a given circumstance.	Analyzing
CO3	Find the probability of getting r events out of n trials. the distribution of binary data from an infinite sample.	Analyzing
CO4	to identify the strength and direction of a linear relationship between two variables and using regression to predict how much a dependent variable changes based on adjustments to an independent variable, you are empowered to make objective, data-driven decisions regarding your processes.	Analyzing
CO5	Understand the test is a statistical procedure for determining the difference between observed and expected data. The test can also be used to determine whether it correlates to the categorical variables in our data.	Understanding

Detailed Contents	**BIOMEDICAL STATISTICS** BM-305 /2375		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Introduction, Difference between biostatistics and statistics, application and use of biostatistics in medical, types of data, collection of data, morbidity, mortality, fertility and demography indicators, sources of medical data, Diagram representation of medical data, bar, pie, line, scatter, histogram, polygon, chart.	9	-
II	Measures of central tendency: Arithmetic mean, Geometric mean, Harmonic mean, Median, Mode, percentile, decile, quartile, tertile. Measures of Dispersion: Range, mean deviation, standard deviation, variance, coeffecient of variance, skewness, methods of measuring skewness, kurtosis, measures of kurtosis.	9	-
III	Introduction of probability, addition and multiplication laws of probability, Bayes' theorem, binomial distribution, Poisson distribution, Normal distribution, Application of distribution.	9	-
IV	Correlation, type of correlation, Method of determining correlation: Scatter diagram method, Karl Pearson's coefficient of correlation, Spearman' rank coefficient of correlation, regression analysis, types of regression, models, curve of regression, line of regression.	9	-
V	Sampling, methods of sampling, random, non random sampling hypotheses test, Null hypotheses, chi square test, F test, Z-test, Student's t-test, degree of freedom, one way analysis of variants, ANOVA.	9	-
	Total	**45**	-

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes, PO: Program Outcomes, PSO: Program Specific Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	B.V. Ramana R.P. Tripathi & Harendra Sing	Higher Engineering Mathematics, Tata Mc Graw Hill Publication. Engineering Mathematics Vol-III, Ram Prasad & Sons Publications.

Course Title	**ELECTRONICS ENGINEERING LAB**				
Course code	**BM-351/ 20376**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester- III
	0	0	2	1	
Pre-requisites (if any)	None. Desirable– Knowledge of Electronic Devices				
Course Objective	To attain expertise in lab equipment handling and understanding the basic devices, their properties, characteristics in detail. Along with their practical usage in the circuit.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Demonstrate the operations of Millimeters, Electronic Component Testing On Bread Board.	Applying
CO2	Plotting VI Characteristics of PN Junction Diode, and Zener Diode. Using Voltmeters and Ammeters integrated on LAB kit.	Applying
CO3	Understanding Operation of CRO and Obtain/Trace Input and Output Waveforms of Rectifiers on it.	Understanding
CO4	Understand behavior of BJT and FET by plotting its Input and output characteristics	Understanding
CO5	Calculating h-Parameters of BJT using LAB kit and apply it for calculating gains and Impedances of amplifiers.	Evaluating
CO6	Understand the Behavior of Power Electronic Devices by plotting its VI Characteristics.	Understanding

ELECTRONICS ENGINEERING LAB – I BM-351/ 20376
LIST OF PRACTICALS

1. Study of lab equipment's and components: CRO, Multi meter, Function Generator, Power supply, Active, Passive Components & Bread Board
2. P-N Junction Diode: Characteristics of PN Junction Diode-Static and dynamic resistance measurement from graph.
3. Applications of PN junction diode: Half & Full wave rectifier- Measurement of Vrms, Vdc, and Ripple factor-use of filter- ripple reduction (RC Filter)-Clipper & Clamper.
4. Properties of junctions Zener diode characteristics. Heavy doping alters the reverse characteristics. Graphical measurement of forward and reverse resistance.
5. Application of Zener diode: Zener diode as voltage regulator. Measurement of percentage regulation by varying load resistor.
6. Characteristic of BJT: BJT in CB and CE configuration- Graphical measurement of h parameters from input and output characteristics. Measurement of Av, AI, Ro and Ri of CE amplifier with potential divider biasing.
7. Characteristic of FET: FET in common source configuration. Graphical measurement of its parameters gm, rd & gm from input and output characteristics.
8. Characteristic of silicon-controlled rectifier.
9. To plot V-I Characteristics of DIAC.
10. To draw V-I characteristics of TRIAC for different values of Gate Currents.

Course Title	**HUMAN ANATOMY AND PHYSIOLOGY LAB**				
Course code	**BM-352 / 20377**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester III
	0	0	2	1	
Pre-requisites(if any)	Practical lab Devices				
Course Objectives	• To provide the basic knowledge of anatomy and Physiological Structures and their Functions. • To understand importance of skeletal Structures and their part of organs, cells and tissues.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Understand the Human anatomy and their functions.	Understanding
CO2	Understand basic function of Heart, Kidney ,Lungs in humans.	Understanding
CO3	Describe the cells, tissues and organs.	Understanding
CO4	Solve problem with engineering applications .	Applying

HUMAN ANATOMY AND PHYSIOLOGY LAB BM-352 / 20377

1. To attain expertise in identification of various parts and components of human skeleton.
2. Identification of all the long and small bones, different joints, skull, jaw and facial bones in human skeleton.
3. Study of human eye and ears with help of 3D model.
4. Identification of respiratory passage components and various lobes of Human lungs.
5. Study of human kidney with the help of 3 D model.
6. Study of blood cells, their morphological identification and counting.
7. Study of human blood groups.
8. Preparation of slides of various tissues (epithelial, connective) and their microscopic study

Course Title	NETWORK LAB

Course code	**BM-353/ 20378**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester III
	0	0	2	1	
Pre-requisites (if any)	None. Desirable– Knowledge of basic electrical circuits.				
Course Objectives	To make the students capable of analyzing any given electrical network. To make the students learn how to synthesize an electrical network from a given impedance/admittance function.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	apply the knowledge of basic circuital law and simplify the network using reduction techniques	Understanding
CO2	Analyze the circuit using Kirchhoff's law and Network simplification theorems.	Evaluating
CO3	Infer and evaluate transient response, Steady state response, network functions	Applying
CO4	Obtain the maximum power transfer to the load , and Analyze the series resonant and parallel resonant circuit	Applying
CO5	evaluate two-port network parameters , design attenuators and equalizers	Evaluating

1. Verification of principle of superposition with dc & ac sources
2. Cross verification of Thevenin. Norton, Maximum power transfer theorem in ac input powerconsumption.
3. Verification of Tellegen's Theorem for two networks of some topology
4. Transient response of RC circuits.
5. Transient response of RLC circuits.
6. Frequency response of RLC circuits
7. Determination of two port-z and h-parameters (dc only and computation of other parameters.
8. Determination of z-parameters of a T-network and computation and realisation of corresponding □- network. Write Demo for the following (in MS-Powerpoint)
9. Verification of parameter properties in inter-connected two port networks: series parallel and cascade(loading effect in cascade)
10. Frequency response of twin-T notch filter.

Institute may add any three experiments in the above list as per the infrastructure available.

Course Title	MEASUREMENT LAB

Course code	**BM-353/20379**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester III
	0	0	2	1	
Pre-requisites(if any)	None. Desirable– Knowledge of Electronic measurement technique				
Course Objective	• To know the procedures for measuring Resistance, Inductance and Capacitance of different ranges. • To perform experiments to measure three phase power, frequency, core losses. • To design experiments for calibration of energy meter. • To know the industrial practices of Measuring earth resistance, dielectric strength of transformer oil & Testing of underground cables.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Understand the concepts of measurement, error and uncertainty.	Understanding
CO2	Understand the static and dynamic characteristics of measuring instruments.	Understanding
CO3	Gain knowledge about the principle of operation and Characteristics of different types of resistance, capacitance and inductance transducers.	Understanding
CO4	Acquire knowledge of analyzing different stages of signal conditioning units.	Applying
CO5	Ability to work as a member of a team while carrying out Experiments.	Applying

1. Study of semiconductor diode voltmeter and its us DC average responding voltmeter.
2. Study of L.C.R. bridge and determination of the value of the given components.
3. Study distortion factor meter and determination of the % distortion given oscillator.
4. Study of the transistor tester and determination of the parameters of the given transistor.
5. Measurement of phase difference and frequency using CRO. (lissajous figure)
6. Measurement of low resistance Kelvin's Double Bridge.
7. Measurement of displacement with help of LVDT.
8. To Draw characteristics of following temperature Transducers: (a)- PT-100, (b)- Thermistor. (c)- Thermocouple.
9. Draw the characteristics between temperature and voltage of a K type Thermocouple..
10. Measure of strain force with the help of strain gauge load cell.

Course Title	**DIGITAL ELECTRONICS**

Course code	**BM- 401/2376**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester IV
	3	1	0	4	
Pre-requisites (if any)	None. Desirable– Knowledge of Logic gates				
Course Objectives	The objective of this course is to impart • To Introduce with Binary Algebra Boolean Functions and Logic Gates • To understand the problem and solve it using Truth table and Boolean functions. • To learn the Designing Combinational and Sequential Circuits • To introduce Logic Families.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Introducing Binary Number system and Arithmetic, Boolean algebra. Minimization schemes, Designing an Example and implement Using Basic logic Gates also Converting it Using Universal Gates.	Understanding
CO2	Designing SSI(Gate Level) circuits by Applying the concepts of Truth Table, K Map and logic Gates	Applying
CO3	Understand the Logic of Combinational Circuits and Design MSI circuits and PLDs	Applying
CO4	Understand the Logic of Sequential Circuits and Design them Using flip-flops by Applying Concept of Characteristics and Excitation Tables	Applying
CO5	Understand Various Logic Families on the Basis of Device Technologies. Also Compare their Electrical switching Characteristics.	Understanding
CO6	Understand the impairments associated with Digital Circuits Like Hazards, Glitches and Races and their Remedies.	Understanding

Detailed Content	**Digital Electronics BM- 401/2376**		
Modules	**Contents**	**L (Hours)**	**T (Hours)**
I	Digital system and binary numbers: Signed binary numbers, binary codes, cyclic codes, error detecting and correcting codes, hamming codes. Floating point representation Gate-level minimization: The map method up to five variable, don't care conditions, POS simplification, NAND and NOR implementation, Quine Mc-Clusky method (Tabular method).	10	-
II	**Combinational Logic**: Combinational circuits, analysis procedure, design procedure, binary adder-sub tractor, decimal adder, binary multiplier, magnitude comparator, decoders, encoders, multiplexers	9	-
III	**Synchronous Sequential logic:** Sequential circuits, storage elements: latches, flip flops, analysis of clocked sequential circuits, state reduction and assignments, design procedure. Registers and counters: Shift registers, ripple counter, synchronous counter, and other counters.	10	-
IV	**Memory and programmable logic:** RAM ROM, PLA, and PAL. Design at the register transfer level: ASMs, design example, design with multiplexers.	9	-
V	**Asynchronous sequential logic:** Analysis procedure, circuit with latches, design procedure, reduction of state and flow table, race free state assignment, hazards.	9	-
	Total	**47**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	M. Morris Mano and M. D. Ciletti	"Digital Design", 6th Edition, Pearson Education
2	S. Salivahanan	"Digital Circuits and Design" , 5th Edition,Oxford University Press
3	A K Maini	"Digital Electronics",2019 Wiley
4	A. K. Singh	"Foundation of Digital Electronics & Logic Design," New Age Int. Publishers.
5	Hill & Peterson	"Switching Circuit & Logic Design", Wiley
6	A. Anand Kumar	" Fundamentals of Digital Circuits" 4th Edition,PHI
7	W.H. Gothmann	"Digital Electronics- An Introduction to Theory and Practice," PHI, 2nd edition, 2006.

Electronics materials, Web Site, etc: www.nptel.ac.in

Course Title	**ELECTRONIC CIRCUITS**

Course code	**BM-402/ 2377**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester IV
	3	1	0	4	
Pre-requisites(if any)	None. Desirable– Knowledge of Basic Electronics				
Course Objectives	The objective of this course is to impart • To Introduce the Properties and Characteristics of Electronic Devices • To understand the Operations of BJT, FET, in various circuit configurations. • To Design Various Circuits using Op Amp IC 741. • To Apply the Circuit Configurations in Industrial and Communication Circuits				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Recognize the Electronic Circuit, functions of Devices the contained and uses.	Understanding
CO2	Classify Various Amplifiers based on their application and understand their characteristics and Design Parameters	Understanding
CO3	Understand the functioning of OP-AMP and design OP-AMP based circuits	Applying
CO4	Understand the frequency response of Various Amplifiers and their design by manipulating capacitances	Understanding
CO5	Understand the concept of negative feedback, their advantages and Applications.	Understanding
CO6	Design sinusoidal and non-sinusoidal oscillators.	Evaluating

Detailed Contents **Electronic Circuits BM-402/ 2377**

Modules	Contents	L (Hours)	T (Hours)
I	**Operational Amplifier:** Inverting and non-inverting configurations, difference amplifier, Effect of finite open loop gain and bandwidth on circuit performance, large signal operation of op-amp	9	-
II	**MOSFET:** Review of device structure operation and V-I characteristics. Circuits at DC, MOSFET as Amplifier and switch, Biasing in MOS amplifier circuits, small-signal operation and models, single stage MOS amplifier, MOSFET internal capacitances and high frequency model, frequency response of CS amplifier	10	-
III	**BJT**: Review of device structure operation and V-I characteristics, BJT circuits at DC, BJT as amplifier and switch, biasing in BJT amplifier circuit, small-signal operation and models, single stage BJT amplifier, BJT internal capacitances and high frequency model, frequency response of CE amplifier.	9	-
IV	**Differential Amplifier:** MOS differential pair, small signal operation of the MOS differential pair, BJT differential pair, other non-ideal characteristic of the Differential amplifier (DA), DA with active load.	9	-
V	**Feedback**: The general feedback structure, properties of negative feedback, the four basic feedback topologies, the series-shunt feedback amplifier, the series-series feedback amplifier, the shunt-shunt and shunt series feedback amplifier. **Oscillators:** Basic principles of sinusoidal oscillators, op-amp RC oscillator circuits, LC oscillator.	10	-
	Total	**47**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	A. S. Sedra and K. C. Smith	"Microelectronic Circuits", Oxford University Press, 5th Ed
2	Jacob Millman, C, Halkias	Integrated Electronics, Second Edition TMH
3	Robert L Boylestad, L Nashelkky	"Electronic Devices and Circuit Theory", 10th Edition, Pearson Publication.

Electronics materials, Web Site, etc: www.nptel.ac.in

Course Title	Sensors & Transducer in Biomedical Instrumentation

Course code	**BM-403/ 2378**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester IV
	3	0	0	3	
Pre-requisites(if any)	None. Desirable– Knowledge of basic physics				
Course Objectives	The objective of this course is to impart • To expose the students to various sensors & transducers for measuring mechanical quantities. • To understand the specifications of sensors and transducers. • To learn the basic conditioning circuits for various sensors & transducers. • To introduce advances in sensor technology.				
Course Outcomes On the successful completion of the course, students will be able to					
CO1	Recognize the transducer and sensors and their importance. Classify various transducers. List the specifications of the measuring instruments in terms of its performance Parameters.				Understanding
CO2	Distinguish among transducers, sensors and converters.				Analysing
CO3	List the criteria in the selection of instrumentation system for the desired measurement application.				Remembering
CO4	Identify the active and passive transducers with applications. Explain elastic transducers.				Understanding
CO5	Understand and become familiar with the sensors commonly used in industrial applications.				Evaluating
CO6	Understand the requirement of signal conditioning and methods.				Understanding

Detailed Contents	**Sensors & Transducer in Biomedical Instrumentation**	**BM-403/ 2378**

Module	Contents	L(Hours)	T (Hours)
I	Generalized instrumentation system, General Properties of Transducers, statistic characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift Hysteresis, Linearity, loading effect, Input Impedance and Output Impedance, Dynamic Characteristics, First and second order characteristics, time delay, error free instruments. Transfer function, design criteria, generalized instruments specifications.	10	-
II	Strain gauge, bridge circuit. Displacement and pressure measurement, Resistive- Potentiometers. Inductive-variable inductance and LVDT, Capacitive type, piezoelectric transducers. Type of diaphragms, bellows, bourdon tubes.	8	-
III	Temperature measurement: Thermistor, Thermocouple, Resistive temperature detector, Radiation Thermometry, fiber optic sensor, measurement geometrical. Flow measurements: Plethysmography, Electromagnetic, Indicator, Indicator Dilution, Thermal convention and ultrasonic.	9	-
IV	Chemical Transducers: Blood gas and acid- base physiology, reference electrode, Ph, pO2, pCo2 Electrodes, Transcutaneous arterial Oxygen tension, Carbon dioxide tension monitoring, enzyme electrode.	8	-
V	Bio-potential electrode, polarizable and non polarizable electrodes, motion artifact, body surface electrodes, Internal electrodes-needle and wire electrodes (different types), Micro electrodes-metal supported metal, Properties of Microelectrodes, Electrodes used for measurement of ECG, EEG, and EMG. MEMS: Fundamental of MEMS, Intelligent and network sensors, network sensors and intelligent instrumentation systems, future trends: neurosensors, smart sensors.	10	-
	Total	**45**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	R.S Khandpur	Handbook of biomedical Instrumentation.
2	John G.Webster (Mareel Dekkar Pub.)	Medical Instrumentation, Application and design.
3	Harry N. Narton (pLenumPress)	Biomedical Sensors-Fundamental of Application
4	Leslli Cromwell, fred Weibell	Biomedical Instrumentation.

Electronics materials, Web Site, etc:
https://www.academia.edu/39250912/Handbook_of_Second_Edition_Biomedical_Instr

Course Title	SIGNALS AND SYSTEMS

Course code	**BM-404/2379**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester IV
	3	0	0	3	
Pre-requisites (if any)	None. Desirable– Knowledge of basic elementary signals.				
Course Objectives	The objective of this course is to impart • To identify whether a given system exhibits these properties and its implication for practical systems. • To able to perform the process of convolution between signals and understand its implication for analysis of linear time-invariant systems.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Analysis of different types of signals.	Analysis
CO2	Analysis and determination of Laplace and Z- transform of continuous and discrete time signals respectively.	Evaluating
CO3	Analysis and determination of Fourier transform of continuous and discrete time signals.	Analysis
CO4	Analysis of different types of systems. Determine the linearity, causality, time-invariance and stability properties of continuous and discrete time systems.	Analysis
CO5	Analysis of continuous and discrete systems in time and frequency domain.	Evaluating

Detailed Contents	**Signal and Systems BM-404/2379**		
Module	**Contents**	**L (Hours)**	**T (Hours)**
I	Signals: Definition, types of signals and their representations: continuous-time/discrete-time, periodic/non-periodic, even/odd, energy/power, deterministic/ random, one dimensional/multidimensional; commonly used signals (in continuous-time as well as in discrete-time): unit impulse, unit step, unit ramp (and their interrelationships), exponential, rectangular pulse, sinusoidal; operations on continuous-time and discrete-time signals (including transformations of independent variables).	11	-
II	Laplace-Transform (LT) and Z-transform (ZT): (i) One-sided LT of some common signals, important theorems and properties of LT, inverse LT, solutions of differential equations using LT, Bilateral LT, Regions of convergence (ROC) (ii) One sided and Bilateral Z-transforms, ZT of some common signals, ROC, Properties and theorems, solution of difference equations using one-sided ZT, s-to z-plane mapping.	11	-
III	Fourier Transforms (FT):(i) Definition, conditions of existence of FT, properties, magnitude and phase spectra, Some important FT theorems, Parseval's theorem, Inverse FT, relation between LT and FT (ii) Discrete time Fourier transform (DTFT), inverse DTFT, convergence, properties and theorems, Comparison between continuous time FT and DTFT.	10	-
IV	Systems: Classification, linearity, time-invariance and causality, impulse response, characterization of linear time-invariant (LTI) systems, unit sample response, convolution summation, step response of discrete time systems, stability. convolution integral, co-relations, signal energy and energy spectral density, signal power and power spectral density, properties of power spectral density,	7	-
V	Time and frequency domain analysis of systems: Analysis of first order and second order systems, continuous-time (CT) system analysis using LT, system functions of CT systems, poles and zeros, block diagram representations; discrete-time system functions, block diagram representation, illustration of the concepts of system bandwidth and rise time through the analysis of a first order CT low pass filter.	7	-
	Total	**46**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	P. Ramakrishna Rao	`Signal and Systems' 2008 Ed., Tata McGraw Hill, New Delhi
2	Chi-Tsong Chen	`Signals and Systems', 3rd Edition, Oxford University Press, 2004
3	V. Oppenheim	A.S. Willsky and S. Hamid Nawab, 'signals & System',PEARSON Education, Second Edition, 2003

Course Title	**ELECTROMAGNETIC FIELD THEORY**				
Course code	**BM-405/2380**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester IV
	3	0	0	3	
Pre-requisites (if any)	None. Desirable– Knowledge of basic physics				
Course Objectives	The objective of this course is to impart • Electromagnetic theory is an essential basis for understanding the devices, methods, and systems used for electrical energy. • To impart knowledge about basic ideas of vector calculus, electrostatics, magneto statics and wave applications.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Description of various coordinate systems and their applications in vector calculus.	Analysis
CO2	Explain the concept of electrostatics, current and energy stored in an electric field.	Understanding
CO3	Explain the concept of magneto statics and energy stored in a magnetic field.	Analysis
CO4	Explain the basic concepts of ground, space, sky wave propagation mechanism.	Analysis
CO5	Explain the transmission line theory.	Understanding

Detailed Contents **Electromagnetic Field Theory BM-405/2380**			
Modules	**Contents**	**L (Hours)**	**T (Hours)**
I	Coordinate systems and transformation: Cartesian coordinates, circular cylindrical coordinates, spherical coordinates Vector calculus: Differential length, area and volume, line surface and volume integrals, del operator, gradient of a scalar, divergence of a vector and divergence theorem, curl of a vector and Stokes's theorem, Laplacian of a scalar.	10	-
II	Electrostatics: Electrostatic fields, Coulombs law and field intensity, Electric field due to charge distribution, Electric flux density, Gausses' Law – Maxwell's equation, Electric dipole and flux lines, energy density in electrostatic fields. Electric field in material space: Properties of materials, convection and conduction currents, conductors, polarization in dielectrics, dielectric constants, continuity equation and relaxation time, boundary condition. Electrostatic boundary value problems: Poisson's and Laplace's equations, general procedures for soling Poisson's or Laplace's equations, resistance and capacitance, method of images.	10	-
III	Magneto statics: Magneto-static fields, Biot-Savart's Law, Ampere's circuit law, Maxwell's equation, application of ampere's law, magnetic flux density-Maxwell's equation, Maxwell's equation for static fields, magnetic scalar and vector potential. Magnetic forces, materials and devices: Forces due to magnetic field, magnetic torque and moment, a magnetic dipole, magnetization in materials, magnetic boundary conditions, inductors and inductances, magnetic energy.	10	-
IV	Waves and applications: Maxwell's equation, Faraday's Law, transformer and motional electromotive forces, displacement current, Maxwell's equation in final form. Electromagnetic wave propagation: Wave propagation in lossy dielectrics, plane waves in lossless dielectrics, plane wave in free space, plain waves in good conductors, power and the pointing vector, reflection of a plain wave in a normal incidence.	9	-
V	Transmission lines: Transmission line parameters, Transmission line equations, input impedance, standing wave ratio and power, The Smith chart, Some applications of transmission lines.	8	-
	Total	**47**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	M. N. O. Sadiku	1. "Elements of Electromagnetic", 4th Ed, Oxford University
2	W. H. Hayt and J. A. Buck	2. "Electromagnetic field theory", 7th Ed., TMH.

Course Title	**DIGITAL ELECTRONICS LAB**				
Course code	**BM- 351/ 20381**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester-IV
	0	0	2	1	
Pre-requisites(if any)	None. Desirable– Knowledge of Digital Electronics				
Course Objectives	To understand the digital logic and create various systems by using these logics.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Verify the Behavior (truth table) of Logic Gates and Satisfying Theorems.	Applying
CO2	Design Digital Circuits for Arithmetic Operations using Logic gates and verifying on Practical Kits in LAB containing Switches, LEDs and Supply voltages.	Applying
CO3	Designing Combinational (MSI) Circuits using SSI ICs. So that student Understand their Constructions.	Applying
CO4	Understanding Operations of MSI ICs like MUX, DECODER, Implementing ROM and other applications.	Understanding
CO5	Design and Verifying Flip flops using gates	Evaluating
CO6	Applying Flip flops for Designing Counters, Registers and State Machines	Applying

DIGITAL ELECTRONICS LAB BM- 451 / 20381
LIST OF PRACTICALS

1. Introduction to digital electronics lab- nomenclature of digital ICs, specifications, study of the data sheet, concept of Vcc and ground, verification of the truth tables of logic gates using TTL ICs.
2. Implementation of the given Boolean function using logic gates in both SOP and POS forms
3. Verification of state tables of RS, JK, T and D flip-flops using NAND & NOR gates.
4. Implementation and verification of Decoder/De-multiplexer and Encoder using logic gates.
5. Implementation of 4x1 multiplexer using logic gates
6. Implementation of 4-bit parallel adder using 7483 IC.
7. Design, and verify the 4-bit synchronous counter.
8. Design, and verify

Course Title	**ELECTRONICS ENGINEERING LAB-II**				
Course code	**BM-452 /(20382)**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester IV
	0	0	2	1	
Pre-requisites(if any)	None. Desirable– Knowledge of Electronic Circuits.				
Course Objective	To design and implement the circuits to gain knowledge on performance of the circuit and its application's.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Verify the operation of Operational Amplifier IC-741 , Its Calibration and Calculation of Parameters of Practical Op-Amps like CMRR and Slew Rate.	Evaluating
CO2	Designing and Verifying Applications Circuits of Op Amp.	Applying
CO3	Demonstrate the Operation and applications Small Signal Voltage Amplifiers Using BJT and FET	Understanding
CO4	Implementing Standard circuits using BJT and FET, like Differential Amplifier, Current Mirror, Level shifter, Darlington Pair, Push-pull.	Applying
CO5	Demonstrate the operations and Applications of various Power Amplifiers.	Evaluating
CO6	Implement and Understand various Sinusoidal and Relaxation Oscillators and Obtaining Their Output waveforms on CRO	Evaluating

ELECTRONICS ENGINEERING LAB-II IC-451/ 20288
LIST OF PRACTICALS

1. Measurement of Operational Amplifier Parameters-Common Mode Gain, Differential Mode Gain, CMRR, Slew Rate.
2. Applications of Op-amp- Op-amp as summing amplifier, Difference amplifier, Integrator and differentiator
3. Field Effect Transistors- Single stage Common source FET amplifier –plot of gain in dB Vs Frequency, measurement of, bandwidth, input impedance, maximum signal handling capacity (MSHC) of an amplifier
4. Bipolar Transistors- Design of single stage RC coupled amplifier –design of DC biasing circuit using potential divider arrangement –Plot of frequency Vs gain in dB. Measurement of bandwidth of an Amplifier, input impedance and Maximum Signal Handling Capacity of an amplifier.
5. Two stage Amplifier. Plot of frequency Vs gain. Estimation of Q factor, bandwidth of an amplifier
6. Common Collector Configuration-Emitter Follower (using Darlington pair)-Gain and input impedance measurement of the circuit.
7. Power Amplifiers-Push pull amplifier in class B mode of operation –measurement of gain.
8. Differential Amplifier –Implementation of transistor differential amplifier. Non ideal characteristics of differential amplifier
9. Oscillators -Sinusoidal Oscillators- (a) Wein-bridge oscillator (b) phase shift oscillator
10. Simulation of Amplifier circuits studied in the lab using any available simulation software and Measurement of bandwidth and other parameters with the help of simulation software.

Course Title	**SENSORS & TRANSDUCERS LAB**				
Course code	**BM-453/20383**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester IV
	0	0	2	1	
Pre-requisites(if any)	Desirable– Knowledge of basic Transducer and Sensor				
Course Objectives	• Introduce students to the principle of various Transducers, their construction, applications and principles of operation, standards and units of measurements. • Provide students with opportunities to develop basic skills in the design of electronic equipment.				

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Examine the characteristics of temperature transducer, Thermistor and Thermocouple.	Analyzing
CO2	Examine the characteristics of LVDT..	Analyzing
CO3	Analyze the characteristics and step response of temperature transducer	Analyzing
CO4	Experiment with balance network of LDR.	Analyzing
CO5	draw characteristics of speed vs voltage on various transducers Magnetic pickup, hall effect, inductive pickup)	Analyzing
CO6	Examine the inductive type transducer	Analyzing

LIST OF PRACTICALS

1. To Draw characteristics of following Transducers:
   (a)- PT-100.
   (b)- Thermistor.
   (c)- Thermocouple.
2. To Perform Load Kit.
   (a)-To Perform experiments and plot curve between load and strain.
   (b)- To study about Excitation.
   (c)-To plot error curve at different loads.
   (d)-To study Piezoelectric vibrations pickup.
3. LVDT:
   (a)-To study excitation and balance network.
   (b)-To study phase difference.
   (c)-To plot curve between displacement and output voltage.
4. Torque measurement:
   (a)-To study about unbalance strain.
   (b)-To plot curve between torque vs strain.
5. To draw characteristics of speed vs voltage on various transducers.(For e.g. Magnetic pickup, hall effect, inductive pickup)
6. To draw characteristics of LDR.
7. To draw characteristics of variable capacitance type transducer.
8. To draw characteristics of variable inductive type transducer.

Course Title	**ELECTRONICS WORKSHOP & PCB LAB**				
Course code	**BM-454/20384**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester IV
	0	0	2	1	
Pre-requisites(if any)	None. Desirable– Knowledge of basic Electronics				
Course Objectives	• This course aims to provide Basic Electrical and Electronics Engineering concepts. • The main objective is to make the students able to understand, design and prepare electrical and electronics circuits using basic concepts.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Design and develop Basic electrical and electronic circuits	Applying
CO2	Explain use of different electrical measuring Instruments and different safety standards.	Understanding
CO3	Demonstrate the construction of electrical machines and connection for different Electrical wirings.	Understanding
CO4	Test the characteristics of protective devices.	Applying
CO5	Design, develop and prepare printed circuit board for electronic and microcontroller-based circuits using software	Evaluating

ELECTRONICS WORKSHOP & PCB LAB BM-454/20384
LIST OF PRACTICALS

Objective: To create interest in Hardware Technology.

1. Winding shop: Step down transformer winding of less than 5VA.
2. Soldering shop: Fabrication of DC regulated power supply
3. Artwork & printing of a simple PCB.
4. Etching & drilling of PCB.

5. Wiring & fitting shop: Fitting of power supply along with a meter in cabinet
6. Testing of regulated power supply fabricated.
7. Breadboard implementation of circuit. like ECG Amplifier, EMG Amplifier, Nerve Stimulator etc. .

CourseTitle	**BIOMEDICAL INSTRUMENTATION**				
Coursecode	**BM- 501 /3371**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester V
	3	0	0	3	
Pre-requisites(ifany)	None. Desirable– Knowledge of fundamental of physiology.				
Course Objectives	• To introduce an fundamentals of transducers as applicable to physiology • To explore the human body parameter measurements setups and make the students understand the basic concepts of forensic techniques. • To give basic ideas about how multimedia evidences are useful in crime investigation.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Understand the physiology of biomedical system.	Understanding
CO2	Measure biomedical and physiological information	Understanding
CO3	Discuss the application of Electronics in diagnostics and therapeutic area.	Understanding
CO4	Differentiate and analyse the biomedical signal sources. Elucidate cardiovascular system and related measurements. Explain the respiratory and nervous systems and related measurements .measure non-invasive diagnostic parameters.	Understanding

Detailed Contents	BIOMEDICAL INSTRUMENTATION BM- 501 /3371		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Introduction to biomedical instrumentation: development of biomedical instrumentation, sources of biomedical signals, medical instrumentation system, physiological systems of body, general constraints in design of medical instrumentation systems, Biometrics.	9	-
II	General consideration of signal conditioners, preamplifiers, main amplifiers and driving stage, sources of noise in low level measurements, biomedical signal analysis techniques, signal processing techniques, writing and recording system, direct writing system, Ink jet recorder, Potentiometric recorder, Ultraviolet recorder, Electrostatic recorder, Thermal array recorder, Light gate array recorder, Instrumentation Tape recorder, X-Y recorder, Medical oscilloscope.	10	-
III	Electrocardiography, waveform and measurement, ECG in diagnosis, arrhythmias, flutter, fibrillation, Phonocardiography, Ballistocardiography. Electromyography, Electroencephalography.	9	-
IV	Patient monitoring System: Concepts, Heart rate meter & alarm, Respiration rate meter, Bloodpressure meter, Temperature indicator. Foetal Monitoring System: - Cardiotacography, Foetal heart Rate (FHR) measurement. Pulmonary Function Analyzer: Pulmonary Function Measurement, Spirometry, Respiratory GasAnalyzer.	9	-
V	Physiological effects of electrical currents, macroshock and microshock, preventive measures to reduce shock hazards, Leakage current, isolation of patient circuits, safety of electrically susceptible patients, radiation hazards and safety, shielding, open ground problem and earthing methods.	9	-
	Total	**46**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	R. S. Khandpur	Biomedical Instrumentation Technology and Applications, McGraw-Hill Professional, 2004
2	Leslie Cromwell, Fred. J. Weibell and Erich. A	. Pfeiffer, “Biomedical Instrumentation and Measurements”, 2nd Edition, PHI, 2003. (UNIT I, III)
3	Raja Rao, C, Guha, S.K,	Principles of Medical Electronics and Biomedical Instrumentation, Orient Longman Publishers (2000) (UNIT V)

CourseTitle	**MICROPROCESSORS & ITS APPLICATION**				
Coursecode	**BM-502/3372**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester V
	3	0	0	3	
Pre-requisites (ifany)	None. Desirable– Knowledge of Digital Electronics				
Course Objectives	The objective of this course is to impart • To expose the students to Stored Programme Control Concept • To Understand the Basic Architecture of a Microprocessor • To learn the basic and Advanced Programming in Assembly language for 8085 & 8086. • To introduce interfacing Devices and advances Microprocessors.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	To Analyse the Functional Block Diagram of Intel's 8085 Microprocessors. And Learn its Pin Diagram with functions.	Analysing
CO2	To Analyse the Functional and understanding the Block Diagram of 8086 Microprocessors .	Understanding
CO3	To analyse the function of interfacing device.	Learning
CO4	Evaluate Time Delay , Apply Call Return Concepts in Real Time Applications	Evaluating
CO5	Applying the Stack Subroutine and Call Return Concepts and Apply them in Modular program.	Applying

Detailed Contents	MICROPROCESSORS & ITS APPLICATION BM-502/3372		
Module	**Contents**	**L (Hours)**	**T (Hours)**
I	**The 8085 Processor:** Introduction to Microprocessor, 8085 Microprocessor, architecture and its instruction set.	9	-
II	**The 8086 Microprocessor:** Architecture, block diagram of 8086, memory segmentation physical address computations, program relocation, addressing modes, Pin Diagram and description of various signal instruction formats, instruction set, Assembler instruction format , Directives and operations.	10	-
III	**Interfacing Device:** The 8255 PPI chip; DMA Controller (8237).	9	-
IV	**Interrupt and Timer:** 8259 Programmable interrupt controller, Programmable interval timer chips (8253/8254).	9	-
	Total	**39**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Ramesh Gaonkar	Microprocessor Architecture, Programming, and Applications with the 8085", 4th Edition,Penram International Publication (India) Pvt. Ltd
2	. Douglas V. Hall	"Microprocessors and Interfacing", 2nd Edition, TMH, 2006
3	Barry B. Brey	"Intel Microprocessors ", Pearson Publication, 8th Edition
4	K Bhurchandi And A K Ray	"Advanced Microprocessors and Interfacing",3rd Edition , TMH

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**INTEGRATED CIRCUITS**				
Coursecode	**BM-503/3373**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester V
	3	0	0	3	
Pre-requisites(ifany)	Electronic Circuits and Digital Electronics				
Course Objectives	The objective of this course is to • Familiar in the operational amplifier principle- analysis- design and application. • Gain knowledge on the linear and nonlinear applications of operational amplifiers. • Understand the theory and applications of Active filters . • Develop skill to implement and analyze simple digital circuits using CMOS digital IC technology. • Familiar in the ADC- DAC and its classifications. • Understand the working and applications of special function ICs-555Timer IC and PLL.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Explain complete analysis of Op-Amp 741 IC	Understanding
CO2	Illustrate linear and non- linear applications of Op-Amp	Understanding
CO3	Construct different types of filters	Analyzing
CO4	Implement digital circuits, logic gates and memory circuits using CMOS digital IC technology	Understanding
CO5	Gain knowledge about the working of data convertors along with the applications of special ICs such as 555 Timer and PLL	Understanding
CO6	Build multivibrators using 555 Timer IC	Analyzing

Detailed Contents	**INTEGRATED CIRCUITS BM-503/3373**

	Contents	L(Hours)	T (Hours)
I	**Analog Integrated circuit Design**: An overview : current mirror using BJT and MOSFETs, simple current mirror, Wilder current source and cascade current mirror. The 741 Op-Amp: Bias Circuit, short circuit protection circuitry , the input stage, the second stage, the output stage, and device parameter, DC Analysis of the 741: Small Signal Analysis of input stage, second stage,the output stage, Gain, Frequency Response of the 741, A Simplified Model, Slew Rate, Relationship Between f and SR.	9	-
II	**Linear Applications of IC op-amps:** An Overview of Op-Amp (ideal and non ideal) based Circuits V-I and I-V converters, generalized Impedance converter simulation of inductors . Filters: First and second order LP, HP, BP BS and All pass active filters, KHN, Tow-Thomas and State Variable Biquad filters; Sinusoidal oscillators .	9	-
III	**Digital Integrated Circuit Design-An Overview:** CMOS Logic Gate Circuits: Basic Structure CMOS realization of Inverters, AND, OR, NAND and NORGate Latches and Flip flops: The Latch, The SR Flip-flop, CMOS Implementation ofSR Flip-flops, A Simpler CMOS Implementation of the Clocked SR Flip-flop,D flip-flop circuits.	9	-
IV	**Non-Linear applications of IC Op-amps:** Log–Anti Log Amplifiers, Precision Rectifiers, Peak Detectors, Simple and Hold Circuits, Analog Multipliers and their applications. Op-amp as a comparator, Zero crossing detector, Schmitt Trigger, Astable multivibrator, Monostable multivibrator, Generation of Triangular Waveforms	9	-
V	**A/D and D/A convertors.** **Integrated Circuit Timer:** The 555 Circuit, Implementing a Monostable Multivibrator Using the 555 IC, Astable Multivibrator Using the 555 IC. **Phase locked loops (PLL):** Ex-OR Gates and multipliers as phase detectors,block diagram of IC PLL and applications of PLL.	9	-
	Total	**45**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Sedra & Smith	Micro-Electronic Circuits , 7th Edition, Oxford University(2018)
2	Ramakanth A. Gayakwad	Op-Amps & Linear ICs ,Pearson(2015)
3	D. Roy Choudhury and Shail B. Jain	Linear Integrated Circuits - D. Roy Choudhury and Shail B. Jain,Forth edition(2018)
4	Jacob Milliman and Arvin Grabel	Microelectronics ,2nd Edition,TMH(2017)

Electronics materials, Web Site, etc: https://onlinecourses.nptel.ac.in

Course Title	**CONTROL SYSTEM**				
Course code	**BM-504/3374**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester V
	3	0	0	3	
Prerequisites (if any)	None. Desirable– Knowledge of Basic network system and engineering mathematics				
Course Objectives	• . To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis. • To employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system • Formulate different types of analysis in frequency domain to explain the nature of stability of the system.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Describe the basics of control systems along with different types of feedback and its effect. Additionally, they will also be able to explain the techniques such as block diagrams reduction, signal flow graph.	Understanding
CO2	Explain the concept of state variables for the representation of LTIb system.	Understanding
CO3	Interpret the time domain response analysis for various types of inputs along with the time domain specifications.	Evaluate
CO4	Distinguish the concepts of absolute and relative stability for continuous data systems along with different methods.	Understanding
CO5	Interpret the concept of frequency domain response analysis and their specifications.	Applying

Detailed Contents	CONTROL SYSTEM BM-504/3374		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	**Introduction:** Basic Components of a control system, Feedback and its effect, types of feedback control systems. Block diagrams and signal flow graphs, Modeling of Physical systems: electrical networks, mechanical elements, equation of mechanical system, sensors and encoders in control systems, DC motors in control system.	9	-
II	**State-Variable Analysis:** Introduction, Vector matrix representation of State equation, State Transition Matrix, State-Transition Equation, Relationship between State Equations and High-order Differential Equations, Relationship between State Equations and Transfer Functions.	9	-
III	**Time domain Analysis of Control Systems:** Time response of continuous data systems, typical test signals for the time response of control systems, the unit step response and time domain specifications, Steady-State error, Time response of a First order system, Transient response of a Prototype second order system.	9	-
IV	**Stability of Linear Control Systems:** Introduction, Bounded-Input Bounded-output Stability Continuous Data Systems, Zero-input and asymptotic stability of continuous data systems, Methods of determining stability, RH criterion	9	-
V	**Frequency Domain Analysis:** Introduction: Mrωr and Bandwidth of the Prototype Second Order System, Effects of Adding a zero to the Forward path, Effects of Adding a pole to the Forward Path, Nyquist Stability criterion, Relative Stability: Gain Margin and Phase Margin, Stability Analysis with the Bode Plot.	12	-
	Total	**48**	-

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	B.C. Kuo	Automatic Control Systems, 9th Edition wiley Publications.
2	I.J. Nagrath& M .Gopal	Control System Engineering,6th Edn. , New Age Publishers,India

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**ENGINEERING MANAGERIAL ECONOMICS**				
Coursecode	**BM- 505 /3375**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester V
	3	0	0	3	
Pre-requisites(ifany)	None. Desirable– Knowledge of fundamental of Engineering Managerial Economics				
Course Objectives	• To understand the concepts of managerial economics and financial analysis this helps in optimal decision making in business environment. • To be familiar with demand concepts, types of methods or techniques of demand those are used by the entrepreneur or producer. • To have a thorough knowledge on the production theories and cost while dealing with the production and factors of production				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Understand fundamental economic concepts along with role and responsibilities of a manager in a business undertaking	Understanding
CO2	Discuss demand and supply of a product and/or product mix of an organization.	Understanding
CO3	Comprehend the concepts of production and the cost behavior of a product.	Understanding
CO4	Explain different market situations such as monopoly, oligopoly, monopolistic and perfect markets and explanation through graphical representation. Analyze financial statements of an enterprise	Understanding

Detailed Contents ENGINEERING MANAGERIAL ECONOMICS BM- 505 /3375			
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Introduction : Meaning, Nature and Scope of Economics, Meaning of Science, Engineering and Technology. Managerial Economics and its scope in engineering perspective.	8	-
II	Basic Concepts Demand Analysis, Law of Demand, Determinates of Demand, Elasticity of Demand-Price, Income and cross Elasticity. Uses of concept of elasticity of demand in managerial decision.	8	-
III	Demand forecasting Meaning, significance and methods of demand forecasting, production function, Laws of returns to scale & Law of Diminishing returns scale. An overview of Short and Long run cost curves – fixed cost, variable cost, average cost, marginal cost, Opportunity cost.	12	-
IV	Market Structure Perfect Competition, Imperfect competition – Monopolistic, Oligopoly, duopoly sorbent features of price determination and various market conditions.	8	-
V	National Income, Inflation and Business Cycles Concept of N.I. and Measurement. Meaning of Inflation, Type causes & prevention methods, Phases of business cycle.	9	-
	Total	**45**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Koutsoyiannis A :	Modern Microeconomics, ELBS
2	Prof. D.N. Kakkar	Managerial Economics for Engineering.
3	D.N. Dwivedi	Managerial Economics

Course Title	**BIOMATERIALS**				
Course code	**BM-011/3386**				
Category	Elective				
Scheme and Credits	L	T	P	C	Semester V
	2	0	0	2	
Pre-requisites (if any)	None. Desirable– Knowledge of Biomaterial technique				
Course Objectives	• To study of the structure and function of biological systems, using the methods of mechanics. • To develop an ability to visualize and understand the fundamental behavior of structures and solids. • To solve the biomechanical questions and produce quantitative solutions using relevant engineering methods in solid and fluid mechanics.				
Course Outcomes On the successful completion of the course, students will be able to					
CO1	Describe and discuss fundamental concepts of human biomechanical systems and the interaction between the human body and biomaterials, by applying the knowledge of Biological Sciences.				Evaluating
CO2	Know about biomaterials and human biomechanics to critically analyse the fitness for purpose and predict the performance of biomedical devices in selected clinical applications				Applying
CO3	Apply biomechanical standards.				Applying
CO4	Regulations and ethical responsibilities in the process of developing biomaterials and medical devices.				Applying

Detailed Contents BIOMATERIALS BM-011/3386			
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	General principles of biomechanics, Cardio-vascular and pulmonary mechanics, haemodynamics, Rheology of blood, Mechanics of heart valves, heart assist devices, blood vessels with special referenceto atherelerosclerosis, aneurysm. Mechanical properties of RBCs and WBCs and Microcirculation. Mechanics of lymphatic system.	10	-
II	Tissue Biomechanics - Direct, shear, bending and torque actions the corresponding stresses and strains in biological tissues. Stress relaxation and creep, stability and instablity. Bio-mechanical characterisation of bone and the soft connective (skin, tendon, ligaments etc.) covering structure their function and physiological factors.	10	-
III	Movement Biomechanics - Gait Analysis, body and limb mass and motion characteristics, muscle actions, forces transmitted by joints. Joint forces results in the normal and disabled human body. Slow normal and fast gait on the level. Joint replacements.	9	-
IV	Positions of anatomical axis and corresponding movements of the body part, International conventions with respect to above. Types of mechanical forces on joints and their effect. Repetitive and static load.	9	-
V	Principles of designing Prosthesis and orthotics, three point pressure, total contact, partial weight reliving, purpose for providing prostheses and Orthoses, Various aspects regarding diagnosis, prognosis, stature and Socio-economic conditions etc. Classification of Prosthetics and Orthotics: a. Lower Extremity Orthoses and Prostheses b. Upper Extremity Orthoses and Prostheses. c. C. Spinal Orthoses. Material Technology for designing Prosthetics and Orthotics, indigenous metals and their alloys, leather, rubber, thermosplastic and thermosetting resins, wood and binding materials.	11	-
		49	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Ed R.M. Kenedi	A Text Book of Biomedical Engineering
2	Richard Skalak and Shu Chien.	Handbook of Bioengineering

CourseTitle	**BIOELECTRICITY**				
Coursecode	**BM-012 /3377**				
Category	Elective Subject-1				
Schemeand Credits	L	T	P	C	Semester V
	2	0	0	2	
Pre-requisites (ifany)	None. Desirable– knowledge of Fundamentals of signal and system.				
Course Objectives	Introduction to the theoretical and applied aspects of bioelectrical phenomena spanning cells to tissue. Beginning with a quantitative understanding of the basis of electrical excitability, the course cover bioelectrical signal propagation, the physical basis of extracellular potentials and stimulation, biopotential amplifier design and use, and clinically relevant biosignal acquisition and analyses.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Ability to understand the basis of bioelectricity and interpret measurements from bioelectric systems.	Understanding
CO2	Ability to recognize and use equivalent circuit representation of physiologic systems that produce bioelectrical behavior	Understanding
CO3	Ability to analyze and design electrical circuits for the measurement of bioelectric phenomena.	Understanding
CO4	Ability to create a scholarly review and present interpretations of an• advanced topic in bioelectric systems	Understanding

Detailed Contents	BIOELECTRICITY BM-012 /3377		
Module	**Contents**	**L (Hours)**	**T (Hours)**
I	Bioelectricity generation at the cellular & sub cellular level. Different biopotentials and their characteristics	08	-
II	Nernst Equation: Derivations and its significance. Refractory Period Characteristics of Stimulus. Strength-Duration relationship. Electrical equivalent circuit of Axon. Membrane time and space constants.	09	-
III	Hodgkin-Huxley formulation, Membrane conductance, Nerve conduction, membrane properties from current voltage relations, Models of squid axon. Propagation of impulses in unmyelinated and myelinated nerve fiber. Electrical properties of receptors. Intensityfrequency relationship. Electrical properties of synaptic junctions - EPSP and IPSP.	11	-
IV	Characteristics of Action potentials at SA Node, Atria, A V Node, Purkinje fibers and Ventricles. ECG Complexes. 12 lead ECG. Standard leads of Einthoven. Pericardial leads and Augmented limb leads. Relationship between unipolar extremity leads and standard Bipolar leads. Electrical activity of skeletal muscles, Motor unit potentials, neuromuscular transmission, EMG wave form.	12	-
V	Biopotential electrodes: classification & characteristics. Electrode-Electrolyte Interface, Equivalent Circuit Properties of Needle & Micro Electrodes, Electrodes for Surgery, Physiotherapy & Analytical instruments.	09	-
	Total	**49**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Robert Plonsey and Roger Barr	Bioelectricity.
2	John Webster	Medical Instrumentation.- Application and Design. John Wiley and Sons. Inc., New York. Third edition 2003.
3	L.A Geddes	Principles of Applied Biomedical Instrumentation.

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**ADVANCED SEMICONDUCTOR DEVICES**				
Coursecode	**BM-013 /3378**				
Category	Elective Subject-1				
Schemeand Credits	L	T	P	C	Semester V
	2	0	0	2	
Pre-requisites (ifany)	None. Desirable– Fundamental knowledge of Basic Physics .				
Course Objectives	1- The course is designed to teach the physical principles and operationalcharacteristics of advanced semiconductor electronic devices withemphasis on modern field effect transistors, optoelectronics, memorydevices and semiconductor sensors. 2- This course is designed to introduce physical insights of next generationdevices for IoT and AI.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Modelling and working of state of the art semi counductor devices.	Understanding
CO2	Ability to identify required device characteristics for a specific application.	Understanding
CO3	Also provide foundation on for advanced courses in nano and quantum electronics.	Understanding

Detailed Contents	**ADVANCED SEMICONDUCTOR DEVICES BM-013 /3378**		
Module	**Contents**	**L (Hours)**	**T (Hours)**
I	Review of Fundamentals of Semiconductors: Semiconductor Materials and their properties Carrier Transport in Semiconductors Excess Carriers in Semiconductor.	08	-
II	Junctions and Interfaces: Description of p-n junction, Action, The Abrupt Junction, Example of an Abrupt Junction, The linearly graded Junction.	08	-
III	The Ideal Diode Model, Real Diodes, Temperature Dependence of I-V Characteristics, High Level Injection Effects, Example of Diodes. Description of Breakdown Méchanism, Zener and Avalanche Breakdown in p-n Junction III Majority Carrier Diodes: The Tunnel Diode, The Backward Diode, The Schottkey Barrier Diode, Ohmic Contacts Heterojunctions.	10	-
IV	Microwave Diodes: The Varactor Diode, The p-i-n Diode, The IMPATT Diode, TRAPATT. Diode, The BARITT Diode, Transferred Electron Devices Optoelectronic Devices: The Solar Cell, Photo detectors, Light Emitting Diodes, Semiconductor Lasers.	09	-
V	Metal Semiconductor Field Effect Transistors: Basic Types of MESFETs, Models for I-V Characteristics of Short-Channel MESFETS, High Frequency Performance, MESFETs Structures. MOS Transistors and Charge Coupled Devices: Basic Structures and the Operating Principle, Characteristics, Short-Channel Effects, MOSFET Structures, Charge Coupled Devices.	12	-
	Total	**47**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	M.S. Tyagi	Introduction To Semiconductor Materials And Devices.
2	S. M. Sze,	.Physics of Semiconductor Devices", 2nd Edition.
3	B. G. Streetman and S. Banerjee,	Solid state electronics devices", 5th Edition, PHI.

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**BIOMEDICAL INSTRUMENTATION LAB**				
Coursecode	**BM- 351 /30379**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester V
	0	0	2	1	
Pre-requisites(ifany)	None. Desirable– This is a required course for the Instrumentation and Signal Processing Track.				
Course Objectives	The hardware and instrumentation needed to measure variables from different physiological systems. Electrodes, sensors and transducers. Bioelectric amplifiers. Hardware for measurement of the ECG, EEG, EMG, respiratory system, nervous system . Clinical laboratory instruments. Electrical safety. Computers in biomedical instrumentation. Students will have lectures and interactive laboratory exercises.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Biomedical Signals and Instrumentation Sensors: Learn several signals that can be measured from the human body. Specific examples include temperature, electrical, and pressure signals.	Understanding
CO2	Instrumentation Design: Understand theory and design on Wheatstone bridge; inverting, noninverting, differential and instrumentation amplifiers. Design filters necessary to condition and isolate a signal. Understand how signals are digitized and stored in a computer or presented on an output display.	Understanding
CO3	Instrumentation Application: Review the cardiac, respiratory and neural physiological systems. Study the designs of several instruments used to acquire signals from living	Understanding
CO4	Understand how noise from the environment, instruments and other physiologic systems can create artifacts in instrumentation. Understand the theory of how several sensors operate and use these sensors in laboratory sessions. Specific examples include thermistors and electrodes	Understanding

BIOMEDICAL INSTRUMENTATION LAB BM- 351 /30379

1. Measurement of Blood pressure
2. Study of Transducers
3. Designing of active filters - LP, BP, HP, Notch
4. Study of and Design of Instrumentation Amplifier
5. Study of ECG, EMG, EEG machines,
6. Amplitude modulation and detection
7. Servicing of circuit boards of biomedical instrument
8. Frequency modulation and detection
9. Pulse modulation techniques
10. Pulse code modulation.

CourseTitle	**MICROPROCESSORS LAB**				
Coursecode	**BM-352/ 30380**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester V
	0	0	2	1	
Pre-requisites(ifany)	None. Desirable– Knowledge of Assembly Language Programming for 8085				
Course Objective	• To make students familiar with Operations of 8085 Microprocessor unit. • Understand assembly language program of and convert its OPCODES • LOAD, RUN and CHECK the RESULT memory Contents				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Introduction to MPU Kit, Procedure of LOAD EXECUTE and CHECK RESULT using an Example	
CO2	Writing ALP for Addition Subtraction operations for 8085, Obtaining its Opcodes and Execute on MPU	
CO3	Understand and implement JMP and CALL instructions for Looping and verify its Examples	
CO4	Calculate and implement DELAY subroutine and apply it in Practical Applications	
CO5	Understand and implement STACK and Subroutine in ALPs and verify its Examples	
CO6	Understand and Demonstrate the Interfacing of Peripheral Devices.	
CO7	Use of Simulators for 8085 programs on PC	

MICROPROCESSOR LAB BM-352/ 30380
LIST OF PRACTICALS

1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers.
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers
3. To perform multiplication and division of two 8 bit numbers using 8085.
4. To find the largest and smallest number in an array of data using 8085 instruction set.
5. To write a program to arrange an array of data in ascending and descending order.
6. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8085 instruction set.
7. To write a program to initiate 8251 and to check the transmission and reception of character.
8. To interface 8253 programmable interval timer to 8085 and verify the operation of 8253 in six different modes.
9. To interface DAC with 8085 to demonstrate the generation of square, saw tooth and triangular wave.
10. Serial communication between two 8085 through RS-232 C port.

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Course Title	LINEAR INTEGRATED CIRCUITS LAB

Course code	**BM-553 /30381**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester V
	0	0	2	1	
Pre-requisites (if any)	Electronic Circuits and Digital Electronics				
Course Objectives	To design and implement the circuits to gain knowledge on performance of the circuit and its application. These circuits should also be simulated on P spice.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Design and analyze the various linear applications of Op-Amp.	Analyzing
CO2	Design and analyze the various non-linear applications of Op-Amp.	Analyzing
CO3	Design and analyze Filter circuits using op-amp .	Analyzing
CO4	Design and analyze the various applications of 555 timer.	Analyzing
CO5	Explain the working of A/D and D/A converters.	Understanding

1. Measurement of op-amp parameters(open loop gain, input offset voltage, CMRR, Slew rate)
2. Determination of Frequency of op-amp.
3. Precision Rectifier
4. Instrumentation Amplifier.
5. Open loop operation of op-amp comparators schmitt trigger.
6. Astable and mono stable multi vibrator using IC 555.
7. IC Voltage Regulator.
8. Voltage controlled oscillators
9. Phase lock loop..
10. Frequency Multiplier .
11. A/D Convertor & D/A Convertors.
12. Second order active filter, high pass filter and low pass filter realization.

Course Title	**Control System Lab**
Course code	**BM-554/30382**

Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester V
	0	0	2	1	
Pre-requisites(ifany)	None. Desirable– Knowledge of basic control system				
Course Objectives	Classify and evaluate the performance parameters of a system and then with simulation prepare an advance tool to modify the values of the parameter of the system in order to meet the desired need.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Classify different tools in MATLAB along with the basic matrix operations used in MATLAB	Understanding
CO2	Evaluate the poles and zeros on s-plane along with transfer function of a given system.	Evaluating
CO3	Construct state space model of a linear continuous system.	Applying
CO4	Evaluate the various specifications of time domain response of a given system.	Evaluating
CO5	Evaluate the various specifications of frequency domain response of a given system.	Evaluating

CONTROL SYSTEM LAB - BM-554/30382

List of Experiment

1. DC SPEED CONTROL SYSTEM
(a) To study D.C. speed control system on open loop and close loop.
(b) To study of Transient performance, another time signal is added at the input of control Circuit.
(c) To study how eddy current breaking is being disturbance rejected by close and open loop.
2. DC MOTOR POSITION CONTROL
(a) To study of potentiometer displacement constant on D.C. motor position control.
(b) To study of D. C. position control through continuous command.
(c) To study of D.C. position control through step command.
(d) To study of D.C. position control through Dynamic response.
3. AC MOTOR POSITION CONTROL
(a) To study of A.C. motor position control through continuous command.
(b) To study of error detector on A.C. motor position control through step command.
(c) To study of A.C. position control through dynamic response.
4. MAGNETIC AMPLIFIER (a) To study Input / Output characteristic of a magnetic amplifier in mode (i) Saturable Reactor, (ii) Self Saturable Reactor.
5. SYNCHRO TRANSMITTER / RECEIVER
(a) To study of Synchro Transmitter in term of Position v/s Phase and voltage magnitude with respect to Rotor Voltage Magnitude/Phase.
(b) To study of remote position indication system using Synchro-transmitter/receiver.
6. PID CONTROLLER
(a) To observe open loop performance of building block and calibration of PID Controls.
(b) To study P, PI and PID controller with type 0 system with delay.
(c) To study P, PI and PID controller with type 1 system.
7. LEAD LAG COMPENSATOR
(a) To study the open loop response on compensator.
(b) Close loop transient response.
8. LINEAR SYSTEM SIMULATOR
a) Open loop response (i)Error detector with gain, (ii) Time constant, (iii) Integrator
b) (b) Close loop system (I)First order system (II) Second order system (III) Third order system
9. Introduction to MATLAB (Control System Toolbox), Implement at least any two experiment in MATLAB.
a) Different Toolboxes in MATLAB, Introduction to Control Systems Toolbox.
b) Determine transpose, inverse values of given matrix.
c) Plot the pole-zero configuration in s-plane for the given transfer function.
d) Determine the transfer function for given closed loop system in block diagram representation.
e) Plot unit step response of given transfer function and find peak overshoot, peak time.
f) Plot unit step response and to find rise time and delay time.
g) Plot locus of given transfer function, locate closed loop poles for different values of k.
h) Plot root locus of given transfer function and to find out S, Wd, Wn at given root & to discuss stability.
i) Plot bode plot of given transfer function.
j) Plot bode plot of given transfer function and find gain and phase margins
k) Plot Nyquist plot for given transfer function and to compare their relative stability
l) Plot the Nyquist plot for given transfer function and to discuss closed loop stability, gain and phase margin.

CourseTitle	**PHYSIOLOGICAL CONTROL SYSTEM MODELLING**				
Coursecode	**BM-601 /3381**				
Category	Professional Core Course				
Schemeand Credits	L	T	P	C	Semester VI
	3	0	0	3	

Pre-requisites (ifany)	None. Desirable– knowledge of Fundamental anatomy and physiology.
Course Objectives	The principles of control systems involving nerves and hormones are examined. Control at the cellular, tissue, organ system and whole-body levels is explained with reference to the basis of cell excitability, basic functions of the nervous system, muscle contraction, actions of hormones, the immune system and the renal system.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Explain the mechanisms by which substances move through biological membranes, the role membrane transport plays in maintaining the composition of body fluids and the structure of epithelia.	Understanding
CO2	Discuss the components and factors of the innate and acquired immune systems.	Understanding
CO3	Discuss the central and autonomic nervous systems, the integration of neural circuits, nervous reflexes and how environmental stimuli illicit nervous responses.	Understanding
CO4	Explain how the kidneys regulate the volume and composition of body fluids via control of water and electrolyte balance, renal excretion of metabolic waste products and the structure (gross and microscopic) of the renal system.	Understanding
CO5	Explain the relationship between the structure and function of the endocrine system, and how endocrine compounds influence tissues and organs.	Understanding

Detailed Contents PHYSIOLOGICAL CONTROL SYSTEM MODELLING BM-601 /3381

Module	Contents	L Hours	T Hours
I	Approaches to modeling: Mathematical modeling, classification of models, characteristics "of models. Purpose of physiological modeling, Introduction to physiological control system, Example of a physiological control system, Differences	12	-

	between engineering and physiological control stems, Linear models of physiological systems, Distributed parameters versus lumped parameters models, Principle of superposition. Open and closed loop systems, basic concept of feedback, control systems, stability criteria, speed of response.		
II	Modeling of human thermal regulatory system: Parameters involved, control system model etc. Biochemistry of digestion, types of heat loss. from body, models of heat transfer between. Subsystems of human body like skin - core etc. and systems like within body, body environment. Modeling the body as compartments, behavior in simple compartmental system, pharmacokinetic model, multi compartmental system Distribution and accessibility of body water & tissue compartments, ,basis for zero order & first order chemical kinetic behavior in the biological system,. Practical applications of stochastic models to tracer kinetics and pharmacy kinetics	12	-
III	Cardiac vascular system, Modeling and simulation, Theoretical basis, Model development, Heart model, Circulatory model, Computational flow diagram of the cardiac system. Pulmonary mechanics modeling and simulation, Theoretical basis, Model development, Lung" tissue visco-elastance, chest wall, airways, Full model of respiratory mechanics, Interaction of Pulmonary and Cardiovascular models.	10	-
IV	The neuromuscular system : the stretch reflex, the antagonist muscle, two control mechanizes, Golgi tendon organs, experimental validation of the models, Parkinson's syndrome, Models of neurons; the Hodgkin-Huxeley model, the iron-wire model.	9	-
V	Eye movement system and its mathematical model, oculomotor muscle model, linear muscle model.	8	-
	Total	**46**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Michael C Khoo,	Physiological Cont:ol Systems -Analysis, simuiation and stimation, Prentice Hall
2	Ogata Katsuhika,	Morlorn control ngincering, 2nd edition, Prentice Hall of Iu.a of India, 201.
3	John H. Milsum,	Biological Contro! Systen Analysis, McGraw Hil, 1966

Electronics materials, Web Site, etc: www.nptel.ac.in

Course Title	**MICROCONTROLLER & ITS APPLICATION**				
Course code	**BM-602/ 3382**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester VI
	3	0	0	3	

Pre-requisites (if any)	None. Desirable– Knowledge of Microprocessors
Course Objectives	The objective of this course is to impart • To Analyze the Architecture of 8051 Microcontroller and Memory organization. • To Understand the Assembly Language Programming for 8051 • To Interface 8051 with sensors and input devices • To Interface 8051 with displays and Motors.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Demonstrate the basic architecture of 8051 and pin functions	Demonstrate
CO2	Illustrate the programming model and RAM organization of microcontroller	Understanding
CO3	Illustrate Addressing modes and Basic instructions which enable writing assembly language programs.	Understanding
CO4	Demonstrating Operations and Functions of Displays like LCD, LED and Switches and keyboards	Applying
CO5	Demonstrate functions of Motors, Relays and RTCs and implement their Coding in ALP for 8051	Evaluating
CO6	Illustrate the interfacing of 8051 and implement them to design projects on real time problems	Applying

Detailed Contents	**MICROCONTROLLER & ITS APPLICATION BM-602/ 3382**		
Module	**Contents**	**L (Hours)**	**T (Hours)**
I	Introduction, Microcontrollers and Embedded processors, Overview of the 8051, Inside the 8051, Addressing modes.	9	-

II	Instruction Set: Addressing mode, data transfer instruction, logical, arithmetic instruction, bit instruction, branching instructor.	9	-
III	Timers: Control Word, mode of timers, simple programming, generation of square wave. Serial Interface: Introduction, Control Word, mode of serial interface, simple programming.	9	-
IV	Interrupts: Introduction, control word Simple Programming, generation of waveforms. using interrupt, serial interface using interrupt:	9	-
V	Applications: Interfacing of memory, intelligent LCD,8255,ADC,DAC,LED display.	9	-
	Total	**45**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D	The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson, 2nd Edition.
2	Ayala Kenneth	, "The 8051 Microcontroller", Cengage Learning, 3rd Edition
3	Chhabra Bhupendra Singh	"Microcontrollers & its Applications" Dhanpat Rai Publishing Company
4	Ghoshal Subrata	" 8051 Microcontroller Internals, Instructions, Programming and Interfacing"Pearson

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**BIOMEDICAL SIGNAL PROCESSING**				
Coursecode	**BM-603/3383**				
Category	Professional Core Course				
Schemeand Credits	L	T	P	C	Semester VI
	3	0	0	3	

Pre-requisites (ifany)	None. Desirable– Knowledge of Basics Biomedical Signals & Processing
Course Objectives	• To study origins and characteristics of some of the most commonly used biomedical signals, including ECG, EEG, evoked potentials, and EMG. To understand Sources and characteristics of noise and artifacts in bio signals. • To understand use of bio signals in diagnosis, patient monitoring and physiological investigation. • To explore research domain in biomedical signal processing. To explore application of established engineering methods to complex biomedical signals problems.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	The student will be able to model a biomedical system	Evaluating
CO2	The student will be able to understand various methods of acquiring bio signals.	Applying
CO3	The student will be able to understand various sources of bio signal distortions and its remedial techniques.	Evaluating
CO4	The students will be able to analyze ECG and EEG signal with characteristic feature points.	Understanding
CO5	The student will have a basic understanding of diagnosing bio-signals and classifying them.	Understanding

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Detailed Contents	**BIOMEDICAL SIGNAL PROCESSING (BM-603/3383)**		
Module	**Contents**	**L (Hours)**	**T (Hours)**
I	Introduction, Characteristics of Bio - Signals, Types of Signals, Measurement, Transformation. and reduction, computation of signal	10	-

	parameters that are diagnostically significant, stationary and non - stationary bio - signals, Application areas of Bio -Signals analysis - EEG, ECG, Phonocardiogram, Spiro Gram, Evoked Signals.		
II	Z transform introduction, definition, convergence. Inverse Z transforms, Analysis of discrete time systems using Z transforms. Solutions of differential equations. Transfer functions and stability. Unit 3	9	-
III	Fourier transform for continuous signals. Energy spectrum, Properties (without proof), Gibbs phenomena, Auto and cross correlation. Discrete Fourier transforms. Properties (without proof), Inverse DFT. FFT, Decimation in time and decimation in frequency.	9	-
IV	Digital filter design, introduction, Realization of Digital system, canonical form, direct form & Cascade Realization of IIR & FIR Filters. Design of IIR & FIR Filters, Low pass, High Pass, Band Pass Filters using windows – Kaiser Windows.	9	-
V	Data reduction Techniques, Power spectrum analysis, Sampling Theorem, aliasing Nyquist criteria, ADC's and DAC's..	9	-
VI	Digital signals and systems: Classification of systems causal, time varying, time invariant, lumped. Introduction to digital signals systems. Convolution, Auto-correlation and cross correlation , Use of Mat lab signal processing toolbox on various real bio - medical signals.	**9**	
	Total	**55**	-

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Metin Akay (academic press)	Biomedical signal processing:
2	Rabiner and Gold (EEE pub)	Theory and application of digital signal processing:

CourseTitle	**THERAPUTIC INSTRUMENT**				
Coursecode	**BM-604/3384**				
Category	Professional Core Course				
Schemeand Credits	L	T	P	C	Semester VI
	3		0	3	

Prerequisites (ifany)	None
Course Objectives	• Biomedical instrumentation helps physician to diagnose the problems and provide appropriate treatment to human being. • Any type of exercise in engineering analysis, involves the measurement of outputs from an unknown system as they are affected by various combination of inputs.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Classify and recommend suitable therapeutic devices for specific applications	Understanding
CO2	Analyze different types of therapeutic devices including pediatric applications and support.	Applying
CO3	Plan and contribute in design, development and effective usage of therapeutic equipment and assistive device	Evaluating
CO4	Outline the potential electrical hazards for therapeutic equipment and evaluate the patient safety.	Understanding
CO5	Justify the application of lasers and laser in surg	Understanding

Detailed Contents	**THERAPUTIC INSTRUMENT(BM-604/3384)**		
Module	**Contents**	**L (Hours)**	**T (Hours)**

I	**Cardiac Pacemakers & Defibrillators**: Effects of electric field on cardiac muscles and laws of stimulation. External, internal, and Programmable pacemakers. Pulse generator: sensing, output and timing circuits. Power sources, electrodes and leads system, pacing system analyzers. Defibrillators- basic principle and comparison of output wave forms of different DC defibrillator, energy requirements, synchronous operation, implantable defibrillators, defibrillator safety and analyzers, RF ablation treatment for arrhythmia.	11	-
II	**Ventilators & Anaesthetic system**: Basic principles of ventilators, different generators, inspiratory phase and expiratory phase, different ventillatory adjuncts, neonatal ventilators, p based ventilator, ventilator testing. Anaesthesia: Need of anaesthesia, gas used and their sources, gas blending and vaporizers, anaesthesia delivery system, breathing circuits.	9	-
III	**Physical therapy**: Physical therapy principles • Electrical stimulators: Strength-duration curve, types of stimulators, an electrodiagnostic / therapeutic stimulator. Nerve-muscle stimulator: peripheral nerve stimulator, Ultrasonic stimulators, stimulators for pain and relief. • Diathermy: IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy.	10	-
IV	**Surgical Diathermy & LASER**: Principles and applications of surgical diathermy, Physics and engineering of ultrasonic lithotripter, basic principle of extracorporeal shock wave lithotripter. Principle operation of LASER, various application of CO2, argon, He - Ne, Nd – YAG & pulsed ruby LASER, Application of LASER in surgery.	9	-
V	**Electro-surgery & Neonatal care unit:** Electrosurgery machine, electrosurgery circuits, solid state electrosurgery generator circuits, electrosurgery safety, testing electrosurgery units, cautery, light sources, suction apparatus, and sterilizers. Baby incubator, radient warmer and phototherapy unit.	10	-
	Total	**49**	-

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	R. S. Khandpur	"Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
2	Carr & Brown	"Introduction to Biomedical Equipment Technology" Pearson Education, Asia

Course Title	**MEDICAL IMAGING TECHNIQUES**				
Course code	**BM-605/3385**				
Category	Professional Core Course				
Schemeand Credits	L	T	P	C	Semester VI
	3	0	0	3	

Pre-requisites (ifany)	None. Desirable– Basic Knowledge Medical imaging techniques.
Course Objectives	• Medical Imaging Technology student should. Learn the various aspects of imaging technology: USG, CT, MRI and Dental radiography and Mammography. • Handle and position the sick patient. Understand the Radiation Protection measures. • Understand the procedures for dispatch of Films and Reports. Perform Quality control procedures. Effectively use HIS/LIS.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Classify different imaging techniques and suggest suitable imaging methodology for specific applications	Understanding
CO2	Explain the principles of image formation and implement various techniques to analyze the medical images for clinical purposes.	Evaluating
CO3	Apply the tools for different problems in medical imaging and respond technically.	Applying
CO4	Identify and interpret the most effective imaging modality for particular examination.	Understanding
CO5	Demonstrate the physics and principles of operation of X-ray and ultrasound imaging modality.	Understanding
CO6	Demonstrate the potential radiation hazards and implement relevant protective systems.	Understanding & Applying

Detailed Contents	**MEDICAL IMAGING TECHNIQUES BM-605/3385**		
Module	**Contents**	**L (Hours)**	**T (Hours)**

I	Characteristics and propogation of ultrasound in biological tissues, Scanning modes, Doppler ultrasound imaging and application, 3D sonography, Ultrasound imaging system bone densitometers, Echocadiography.	8	-
II	**Properties and production** of X-rays, XRT, Engineering principles of X-ray system, image intensifier, angiography technique, digital radiography, Radiological instruments safety standards, Radiation Exposure and Biological Impact.	9	-
III	**Tomographic Imaging**: Computerized X-Ray tomography, Principles & Schematic of Magnetic resonance Imaging (MRI), Positron emission tomography (PET), SPECT, Thermography, C-Arm Technique	9	-
IV	**CT scan: Principle and Working Angiography**: General Angiography, Magnetic Resonance Angiography, Digital subtraction Angiography, Cine angiography Radiograph: General Radiography, Digital Radiograph and Computed Radiograph Teleradiology:	11	-
V	**Medical Thermography**: Physics of thermography, thermographic equipment, Applications of thermography.	6	-
	Total	**43**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	R.S. Khandpur	Handbook of Biomedical Engineering.
2	Carr- Brown	Introduction to Biomedical Equipment Technology

Course Title	**BIOMECHANICS**				
Course code	**BM-021/3386**				
Category	Elective-II				
Scheme and Credits	L	T	P	C	Semester VI
	2	0	0	2	

Prerequisites (ifany)	None Fundamental knowledge of Biomechanics
Course Objectives	• **The major goal of biomechanics of sport and physical exercise is to improve performance in given sport or physical exercise.** The theory of z–transformations and application for the mathematical analysis of digital control systems. • In a wider context the goal of biomechanics of sport and physical exercise is also to increase physical fitness. • **The secondary goal of sport biomechanics is to provide recommendations for injury prevention and rehabilitation**.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Apply knowledge of biomechanics to analyze the properties of biofluid, hard and soft tissues and identify the appropriate model to demonstrate mechanical behavior.	Applying
CO2	Analyze the biomechanics of different human joints and also forces for various static and dynamic human activities.	Evaluating
CO3	Demonstrate a detailed understanding of the design requirements of medical implants based on the human anatomy and biological responses to biomaterials.	Evaluating
CO4	Interpret and explain the mode of operation of different artificial implants and its medical applications. Interpret technically to the quests of biomechanical team and formulate design specification.	Understanding
CO5	Perform a systematic qualitative biomechanical analysis of human movement activities or skills in sport, exercise, rehabilitation, work, and daily living.	Understanding

Detailed Contents	**BIOMECHANICS BM-021/3386**		
Module	**Contents**	**L (Hours)**	**T (Hours)**
I	General principles of biomechanics, Different operations on vectors, forces and Moments. System of forces in 2D and 3D; Equilibrium equation, Applications	10	-

	with examples on Human Body. Work Energy Equation, Application to Bio-Medical System.		
II	Cardio-vascular and pulmonary mechanics, haemodynamics, Rheology of blood, Mechanics of heart valves, heart assist devices, blood vessels with special reference to atheleroscleros is, aneurysm. Mechanical properties of RBCs and WBCs and Microcirculation. Mechanics of lymphatic system.	9	-
III	Tissue Biomechanics - Direct, shear, bending and torque actions the corresponding stresses and strains in biological tissues. Stress relaxation and creep, stability and instablity. Bio-mechanical characterisation of bone and the soft connective (skin, tendon, ligaments etc.) covering structure their function and physiological factors.	10	-
IV	Movement Biomechanics - Gait Analysis, body and limb mass and motion characteristics, muscle actions, forces transmitted by joints. Joint forces results in the normal and disabled human body. Slow normal and fast gait on the level. Joint replacements..	8	-
V	Positions of anatomical axis and corresponding movements of the body part, International conventions with respect to above. Types of mechanical forces on joints and their effect. Repetitive and static load.	9	-
	Total	**46**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Ed R.M. Kenedi	A Text Book of Biomedical Engineering
2	Richard Skalak and Shu Chien	Handbook of Bioengineering.

Course Title	**LASER AND FIBER OPTICS FOR MEDICAL APPLICATION**				
Course code	**BM-022/3387**				
Category	Elective-II				
Scheme and Credits	L	T	P	C	Semester VI
	2	0	0	2	

Pre-requisites (if any)	None.
Course Objectives	• To make students aware about the meaning and implications of the properties of systems and signals • To make students familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Design and describe different types of realizations of digital systems (IIR and FIR) and their utilities.	Evaluating
CO2	Select design parameters of analog IIR digital filters (Butterworth and Chebyshev filters) and implement various methods such as impulse invariant transformation and bilinear transformation of conversion of analog to digital filters.	Applying
CO3	Design FIR filter using various types of window functions	Evaluating
CO4	Define the principle of discrete Fourier transform & its various properties and concept of circular and linear convolution. Also, students will be able to define and implement FFT i.e. a fast computation method of DFT.	Understanding
CO5	Define the concept of decimation and interpolation. Also, they will be able to implement it in various practical applicati.	Understanding

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Detailed Contents	**LASER AND FIBER OPTICS FOR MEDICAL APPLICATION BM-022 /3387**		
Module	**Contents**	**L (Hours)**	**T (Hours)**

I	**Laser characteristics:** Single frequency operation, coherence of laser, spatial distribution, intensity of laser emission, polarization of laser emission, measurement of pulsed laser energy. Principles of laser applications in medicine and biology.	9	-
II	**Laser in biology:** Optical properties and pathology of laser reaction in skin, thermal effects, laser irradiation-photocoagulation, photothermal ablation, photochemical ablation, photo disruption, Non thermal reactions of laser energy in tissue, effect of adjuvant**.**	9	-
III	**Lasers in surgery:** Surgical instrumentation of CO2, Ruby, Nd-YAG, He-Ne, Argon ion, -switched operations, continuous wave, Quasi- continuous, surgical applications of these lasers.	9	-
IV	**Laser applications:** Lasers in dermatology, lasers in ophthalmology, laser photocoagulations, laser in dentistry, Laser flow cytometry, Laser transillumination & iaphanography - Speckle intereferometry, holography - Application Safety with biomedical Lasers	9	-
V	**Fiber optics in diagnosis:** Transmission of signals, light, and construction details of optical fiber, application of fiber optics in medical field. Light transmission and image transmission system in rigid and flexible endoscopes.	9	-
	Total	**45**	-

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Leon Goldman,	"The Biomedical laser Technology and Clinical Applications "Springer- Verlar
2	Pratesi E.D.R, and Sacchi,	"Lasers in photomedicine and photo biology", Springer-Verlay

Electronics materials, Web Site, etc: www.nptel.ac.in

Course Title	**EMBEDDED SYSTEM IN MEDICINE**				
Course code	**BM 023/3388**				
Category	**Elective II**				
Scheme and Credits	L	T	P	C	Semester VI
	2	0	0	2	

Pre requisites (if any)	Basic knowledge of embedded system in medicine.
Course Objectives	• Be familiar with the composition, design, and implementation of embedded systems, • It provide implementation of interface of biomedical instrumentation

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Understand application of specific embedded systems like sonography,MRI and other biomedical instruments get students familiar with the typical problems and constraints .	Understanding
CO2	Learn about PIC Microcontrollers and Embedded processors, overview of family.PIC microcontroller hardware, input/output pins, ports, and circuits, external memory.	Applying
CO3	Evaluate the application of embedded technology in the medical field appears to have endless possibilities	Evaluating
CO4	Understand benefits of implementing the technology of embedded (hardware and software) into medical Diagnostics and treatment.	Understanding
CO5	Understand theEmbedded technology to reduces the cost medical devices.Also, using embedded technology allows the physician to obtain medical information about a patient.	Understanding

Detailed Contents	**EMBEDDED SYSTEM IN MEDICINE 023/3388**		
Module	**Contents**	**L Hours**	**T (Hours)**
I	**Definition and Classification:** Overview of Processors and hardware units in an embedded system - Software embedded into the system Exemplary Embedded Systems-	12	-

	Embedded Systems on a Chip (SoC) and the use of VLSIdesigned circuits Standards, Embedded System Development Process, Embedded Operating systems, Types of Embedded Operating systems.Definition and Classification Overview of Processors and hardware units in an embedded system Software embedded into the system - Exemplary Embedded Systems - Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits Embedded Hardware Architecture, Communication Interface Standards, Embedded System Development Process, Embedded Operating systems, Types of Embedded Operating systems.		
II	**Electro Optic Effects:** Birefringence phenomenon EO Retardation, EO Amplitude and Phase Modulator, Electro optic Intensity Modulators ,Beam deflection, Acousto-optics, A-O Modulators, Integrated optic spectrum analyzer, Non linear optics second harmonic generation, Parametric amplificationIntel MCSSI Architecture - Derivatives Punction Registers (SFR), W/O pins, ports and circuits, - Instruction set, Addressing Modes, Assembly Language Programming, Timer and Counter Programming Serial Communication, Connection to RS 232, Interrupts Programming, External Memory interfacing Introduction to 16 bit Microcontroller. Interfacing of 8051 with ADC, sensors, stepper motor, key board, & DAC.	12	-
III	PIC Microcontroller - Introduction, CPU architecture, registers, instruction sets addressing modes Loop. timing, timers, Interrupts, Interrupt timing, V/o Expansion, I 2C Bus Operation Serial EEPROM, Analog to digital converter, UART-Baud Rate-Data Handling-Initialisation, Special Features - serial Programming-Parallel Slave Port	9	-
IV	**Optical Fiber Sensors:** Multimode fiber Sensors-Displacement, pressure, stress, strain. Intensity modulated sensors, Active multimode FO sensors, Micro-bend optical fiber sensor, Current sensors, Magnetic sensors, Single mode FO sensors, Phase modulated, Polarization modulated, Fiber Optic Gyroscope.Embedded system evolution trends. Round Robin, robin with Interrupts, function-One- Scheduling Architecture, Algorithms. Introduction to-assembler-compiler-cross compilers and Intergrated Development Environment (IDE). Object Oriented Interfacing, Recursion, Debugging strategies, Simulators. Task and Task States, tasks and data, semaphores and shared Data Operating system Services-Message queues-Timer Function-Events-Memory Management, Interrupt Routines in an RTOS environment, basic design Using RTOS.	12	-
V	Applications: Real-Time Embedded Software Development, Sending a Message over a Serial Link, Simulation of a Process Control System, Controlling an Appliance from the RT Linux System, Embedded Database Applications, Embedded medical applications: Ophthalmology Glaucoma screening device, Medical Imaging Acquisition User Interface, Drug delivery systems, Patient monitoring Systems.	9	-
	Total	**54**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Raj kamal	**"Embedded system Architecture, Programming and design**
2	Tim Wilmshusrst	"Designing Embedded system with PIC newnes publishing 2007

Electronics materials, Web Site, etc:www.nptel.ac.in

Course Title	**PHYSIOLOGICAL CONTROL SYSTEM MODELLING LAB**
Course code	**BM- 651/30389**
Category	Professional Core Course

Scheme and Credits	L	T	P	C	Semester VI
	0	0	2	1	
Prerequisites (if any)	None				
Course Objectives	• Appreciate the role of physiological Modeling • To understand complex physiological systems by design and model-oriented explorations. • Apply computerized simulation tools using an instruction manual. • Understand the variety in the utilities of the simulation tools (MATLAB Simulink).				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Recognize the different goals of physiological modeling. Appreciate the role of physiological and human – machine models in medicine, industry and marketing. Understand the basic strengths and limitations of quantitative modeling. Appreciate the dynamic nature of the models.	Understanding
CO2	Read, understand, and apply knowledge gained from scientific literature in math, physical science, biology, physiology, computer science, electric networks, and engineering.	Applying
CO3	Represent a physiological component by another non-physiological one. Manipulate the physiological parameters and analyse the corresponding results by curve fitting and sensitivity analysis. Design physiological systems and conduct computerized model-oriented experiments.	Understanding
CO4	Master SIMULINK applications of physiological simulation on MATLAB.	Evaluating
CO5	Understand the block diagram concept of SIMULINK and blocks interactions (graphical interface) on MATLAB.	Evaluating

PHYSIOLOGICAL CONTROL SYSTEM MODELING LAB-651/30389

1. To Study the Cardiovascular system.
2. Simulation of Cardiovascular system by using MATLAB/SIMULINK.

3. To Study the Heart Model and simulate it using MATLAB/SIMULINK. 4.
To Study the Eye Movement System, its mathematical mode.
5. To study linear muscle model.
6. To study model of respiratory mechanics.
7. Implement the simulink model for Lung Mechanics.
8. Implement the glucose insulin regulation model by MATLAB tools.
9. To study the circulatory model by MATLAB.
10. Implement the simulink model for neuromuscular transient response.

Important: Four Experiments should be added in above as per the requirement of the relevant subject.

CourseTitle	**MICFROCONTROLLER LAB**				
Coursecode	**BM-652 (30390)**				
Category	Professional Core Course				
Schemeand Credits	L	T	P	C	Semester VI
	0	0	2	1	
Pre-requisites (ifany)	None. Desirable– Knowledge of Assembly Language Programming for 8051				

Course Objectives	• To study programming based on 8086 microprocessor and 8051 microcontroller. • To study 8086 microprocessor based ALP using arithmetic, logical and shift operations. • To study modular and Dos/Bios programming using 8086 micro processor. • To study to interface 8086 with I/O and other devices. • To study parallel and serial communication using 8051 micro controller.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Construct and apply the assembly level programming of microprocessor and microcontroller.	Appling/ Understanding
CO2	Develop the programming logic and concept with the help of algorithm or flowchart.	Applying
CO3	Troubleshoot assembly language program along with interactions between software and hardware	Understanding
CO4	Practice the interfacing of microprocessor with peripheral devices for various applications..	Evaluating

MICROCONTROLLER LAB Code: BM-652 (30390)

1. Study of 8051 Microcontroller, Architecture & command.
2. Write an ALP for the Addition & Subtraction of 8 bit no's.
3. Write an ALP for multiplication of Two 8 bit no's.
4. Write an ALP for Division of Two 8 bit no's.
5. Write an ALP to find smallest & largest no in a given array.
6. Write an ALP to generate 10 KHz frequency using interrupt.
7. Write an ALP to interface intelligent LCD display with m C.

8. Write an ALP for m C & HLL for PC (VB/C++/VC++) to demonstrate/implement serial Interfacing.
9. Write an ALP to interface LED display.
10. Write an ALP to interface one m C with other using serial/parallel communication.
11. Write an ALP to switch ON alarm when m C receive interrupt

Important: Three Experiments should be added in above as per the requirement of the relevant subject..

Course Title	**BIOMEDICAL DIGITAL SIGNAL PROCESSING LAB**				
Course code	**BM-653 (30391)**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester VI
	0	0	2	1	
Pre-requisites (ifany)	None. Basic Knowledge of Biomedical signals.				
Course Objectives	• Developing advanced signal processing and estimation methods for analyzing and understanding biomedical signals.				

	• Advancing our knowledge of pathophysiology through the investigation of behavior that manifests in physiologic signals. • Providing opportunities for student participation in rigorous research methodology and the dissemination of knowledge. • Contributing to regional and national biomedical research.

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Perform basic signal processing operations and implement various DSP systems.	Appling
CO2	Design and implement digital filters for biosignal processing.	Applying
CO3	Program the digital signal processing algorithm using software.	Understanding
CO4	Analyze biosignals and perform computation depending on the application.	Evaluating

BIOMEDICAL DIGITAL SIGNAL PROCESSING LAB BM-653 (30391)
LIST OF PRACTICALS

1. Realization of signal-continuous & discrete by using MATLAB.
2. Write a MATLAB program to perform convolution of two signals.
3. Write a short program to perform
(a) DFT
(b) Inverse DFT
(c) FFT By using MATLAB.

4. By using toolbox(MATLAB) simulate
(a) FIR Filter
(b) IIR Filter
5. Data acquisition of EEG & ECG signals by using DSP kit.
6.Noise removal from EEG & ECG signals
7. Power spectrum analysis of EEG signals.

Important: Five Experiments should be added in above as per the requirement of the relevant subject.

Course Title	**OPERATIONS RESEARCH BM- OE- 071/4371**				
Course code	Open Elective Course				
Scheme and Credits	L	T	P	C	Semester VII
	3	0	0	3	
Pre-requisites(if any)	**Basic Knowledge of mathematics**				
Course Objectives	• To solve and evaluate the problem on LLP • How To Evaluate Optimal Sol. For any basic problem • Applications of probability on daily life problem.				
Course Outcomes Student gets good knowledge about complex problems in Industries and their implementation.					
CO1	Able to understand what is the use of operations research , how to sol. Various OR models, LLP Problems for any analysis				Understanding
CO2	Able to understand type of transportation problems in OR to find optimal sol. For job assignment in industries				Understanding
CO3	Able to understand to increase industries output by applying shortest path method in various CPM and PERT network				Understanding
CO4	Able to understand how to solve optimal solution for any Game problem link 2 x n or m x 2 games using various type strategies. Application of Queuing in industries.				Understanding
CO5	Able to apply how to increase output of the industries using inventory control using time model.				Applying

Detailed Contents	OPERATIONS RESEARCH BM-OE-071 / 4371		
Modules	**Contents**	**L(Hours)**	**T (Hours)**
I	Introduction : Definition and scope of OR, OR model , solving the OR model, art of modeling , phases of OR study. Linear Programming Two variable linear programming model and Graphical method of solution , simplex method , dual simplex method, special cases of linear programming , duality, sensitivity analysis	12	-
II	Transportation Problems: Types of transportation problems, mathematical models, transportation algorithms , Assignment: Allocation and assignment problems and models , processing for job through machines .	10	-
III	Network Techniques: Shortest path model, minimum spanning Tree problem, max-flow problem and Min-cost problem. Project Management : Phases of project management , guidelines for network construction , CPM and PERT.	9	-
IV	Theory Of Games : Rectangular games , Minmax theorem , graphical solution of 2 x n or m x 2 games, game with mixed strategies , reduction to linear programming model. Quality System : Elementary of Queuing model , generalized poisson queing model , single server models	7	-
V	Inventory Control : Models of inventory , operation of inventory system , quantity discount . Replacement : Replacement models : Equipment that deteriorate with time , equipment that fail with time	7	-
	Total	**45**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Wayne L winston	Operations Research Thomson (Cengage) Learning, 2003
2	Hamdy H Taha	Operations Research – An introduction : Pearson education 2003

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**ARTIFICIAL ORGANS & REHABILITATION ENGINEERING**				
Coursecode	**BM- 031 /4374**				
Category	Open Elective Course-III				
SchemeandCredits	L	T	P	C	Semester VII
	3	0	0	3	
Pre-requisites(ifany)	None. Desirable– Knowledge of Basics Biological signal processing, Biomechanics, Biomaterials, Electronics				
Course Objectives	to acquaint the student with modern artificial organs devices and methods used to partially support or completely replace pathological organ				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Student gathered the knowledge about the principles, construction and control algorithms of artificial organs. Student knows the main features of biomaterials and the biocompatibility phenomena.	Understanding
CO2	Knows state of the art in Artificial Organ domain.	Analyzing
CO3	Understands the function and relationship between the structure and functionality of chosen artificial organ.	Creating
CO4	Beside of technical problems, occurred during artificial organ construction and control Student is sensitive for other domain problems like ethical, economical, environmental and legal.	Creating
CO5	Student is able to make a synthetic review of literature on new trends in biomaterials, implants and artificial organs and integrate data from different sources.	Analyzing

Detailed Contents ARTIFICIAL ORGANS & REHABILITATION ENGINEERING BM-031/4374			
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Introduction to artificial organs: Biomaterials used in artificial organs and prostheses, inflammation, rejection, correction. Rheological properties of blood, blood viscosity variation: effect of shear rate, hematocrit, temperature and protein contents. Casson equation, flow properties of blood through the blood vessels, problems associated with extracorporeal blood flow.	10	-
II	Artificial kidney: Brief of kidney filtration, basic methods of artificial waste removal, hemodialysis, equation for artificial kidney and middle molecule hypothesis. Hemodialysers: flat plate type, coil type and hollow fiber. Analysis of mass transfer in dialyers (cross current & cocurrent flow), regeneration of dialysate, membrane configuration, wearable artificial kidney machine, separation of antigens from blood in ESRD patients.	10	-
III	Artificial heart-lung machine: Brief of lungs gaseous exchange / transport, artificial heart-lung devices. Oxygenators: bubble, film oxygenators and membrane oxygenators. Gas flow rate and area for membrane oxygenators. Liver support system, artificial pancreas, blood and skin.	9	-
IV	Audiometry: air conduction, bone conduction, masking, functional diagram of an audiometer. Hearing aids: different types, receiver amplifiers. Opthalmoscope, retinoscope, I.A.B.P principle and application.	9	-
V	Rehabilitation Engineering: Impairments, disabilities and handicaps, Measurement and assessment. Characterizing engineering concepts in sensory and motor rehabilitation. Engineering concept in communication disorders. Rehabs for locomotion, visual, speech & hearing. Artificial limb and hands, prosthetic heart valves. Externally powered and controlled orthotics and prosthetics. Myoelectric hand and arm prostheses. The marcus intelligent hand prostheses, gait study, spinal rehabilitation	10	-
	Total	**48**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Robbinson C.J.,	Rehabilitation Engineering. CRC press 1995
2	Gerald E. Miller,	"2Artificial Organs, Morgan & Claypool Publishers, 2006
3	R.S. Khandpur,	Hand book of biomedical instrumentation. Tata Mcgraw Hill Publishers

CourseTitle	**BIOMEDICAL IMAGE PROCESSING**				
Coursecode	**BM- 701 /4376**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester VII
	3	0	0	3	
Pre-requisites(ifany)	None. Desirable– Knowledge of Signal processing and Image processing				
Course Objectives	This course gives an overview of medical image formation, enhancement, analysis, visualization, and communication with many examples from medical applications. It starts with a brief introduction to medical imaging modalities and acquisition systems. Basic approaches to display one-, two-, and three-dimensional (3D) biomedical data are introduced. As a focus, image enhancement techniques, segmentation, texture analysis and their application in diagnostic imaging will be discussed.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Identify major processes involved in formation of medical images. recognize the imaging modality from their visualization. classify the various medical image processing algorithms	Understanding
CO2	Describe fundamental methods of image enhancement. enhance medical images using appropriate software. visualize all types of medical image data	Applying
CO3	Appraise efficacy and drawbacks of several techniques of image segmentation. get familiar with the fundamental concepts of texture analysis	Understanding
CO4	Explain the basic principles of medical image communication	Understanding
CO5	Get started with Image and self-perform fundamentals of medical image processing	Applying

Detailed Contents	BIOMEDICAL IMAGE PROCESSING BM- 701 /4376		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Introduction, light, luminance, brightness and contrast, MTF of the visual system visibility. function, monochrome vision models. Color representation, color matching and reproduction, color vision model Image sampling and quantization, Image quantization, visual quantization.	9	-
II	Point operations; contrast stretching, clipping and threshold, digital negative intensity level slicing, bit extraction, Histogram modeling, histogram equalization, modification, Convolution theorem and correlation, spatial operations. Smoothing techniques.	9	-
III	Two dimensional orthogonal and unitary transforms, properties of unitary transforms–one dimensional DFT cosine, sine Harmrd and Haar transforms.	9	-
IV	Spatial feature extraction, transforms features, Segmentation techniques, Analysis techniques.	9	-
V	Application of MATLAB for Digital image processing.	9	-
	Total	**45**	-

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Jain Anil k.	Fundamental of digital image processing ,Prentice Hall.
2	Reaiel c Gonzalez, Wintz paul.	Digital image processing, Addision Wesley
3	Pratt. WK	Digital image processing, Jonh Wiley & Sons.

Electronics materials, Web Site, etc: www.nptel.ac.in

Course Title	**HOSPITAL MANAGEMENT SYSTEM**				
Course code	**BM- 702 / 4377**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester VII
	3	0	0	3	
Pre-requisites (ifany)	None. Desirable– Basic Knowledge Hospital administration				
Course Objectives	The objective of this course is to impart • To understand the fundamentals of hospital administration and management. • To know the market related research process • To explore various information management systems and relative supportive services. • To learn the quality and safety aspects in hospital.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Explain the principles of Hospital administration.	Understanding
CO2	Identify the importance of Human resource management.	Understanding
CO3	List various marketing research techniques.	Evaluating
CO4	Identify Information management systems and its uses.	Designing
CO5	Understand safety procedures followed in hospitals	Applying

Detailed Contents	**HOSPITAL MANAGEMENT SYSTEM BM-702 / 4377**		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Classification of hospital & architecture: General hospital, specialized hospital, primary health care –their role and functions. Aspects of hospital services –inpatient, outpatient and emergency. Location and environment of hospital, Hierarchy of medical and paramedical staff & their functions and responsibilities. Modern Hospital Architecture- space in a hospital building, design of ward, intensive care units, air conditioning, plumbing & sanitation, gas supply, waste disposal, cleaning, dietary, sterilizing, laundry, storage and operation theatre systems, Radiology, Central labs, Blood banks, OPD, Casualty, etc.	12	-
II	Elements of Safety - Safety Publications and Standards Organizations - Orientation to Laboratory Safety - Types of risks in the hospitals - factors of environment - Safety showers and Eye Washes – Radiation hazards – radiation detection – safety measures – standards. Ergonomics - Flammables and Explosives – Formaldehydes - PEL Standards and Calculations - Material Safety - Organization of Safety in the hospitals. Electrical power systems in hospitals: Safety of electrical systems, Protective systems - interference of patient's protection grounding. Design of sub stations, breakers, Surge protectors, EMI filters, voltage stabilizers, generator sets and UPS. Uninterrupted power supply for ICU and computerized monitoring units. Specification & estimation for hospital wiring - small case study.	12	-
III	Air conditioning & gas supply systems: Air conditioning and refrigeration systems for small and large areas. Air changes, filtering and sterility. Deodourization, disinfection, dehumidification and cryogenic systems. Centralized supply of air, oxygen, nitrous oxide & vacuum - Principle of production of liquid oxygen. Management lifts fire fighting equipments.	9	-
IV	Hospital engineering & Management: Definition of biomedical Engineering, clinical engineering & hospital engineering. Importance of BME department – servicing and maintenance, testing, acceptance & maintenance protocols, Computerized preventive maintenance planning, MROs. Training of men for medical equipments preventive and periodical maintenance procedures. Preparation of estimates, specifications, tender details etc. Importance of ISO 9000 Certificates - Obtaining ISO certificates in hospitals. Proposed protocols. Necessity for standardization, FDA, AERB, Joint Commission of Accreditation of hospitals, ICRP and other standard organization, methods to monitor the standards.	12	-
V	Hospital Information system: Role of database in HIS. Need of Networking in HIS. Overview of Networking, topologies and its configuration. Structuring medical records to carry out functions like admissions, discharges, treatment history etc. Computerization in pharmacy & billing. Automated clinical laboratory systems & radiology information system. Need for evolving health policy, health organization in state, health financing system, health education, health insurance, health legislation.	9	-
	Total	**56**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	P.E.Stanley,	Handbook of hospital safety, CRC Press (UNIT II)
2	Arun Kumar,	Hospital Management, Anmol Publications Pvt. Ltd., Jan 2000 , 1st.ed (UNITS IV & V)

Course Title	**BIOTRANSPORT PHENOMENON**				
Course code	**BM- 703/4378**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester VII
	3	0	0	3	
Pre-requisites (ifany)	None. Desirable– Basic Knowledge of Fluid Mechanics and Biomechanics				
Course Objectives	Transport Phenomena is the subject which deals with the movement of different physical quantities such as momentum, energy and mass in any chemical or mechanical process and combines the basic principles (conservation laws) a n d laws of various types of transport.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Introduction to transport phenomena Vector and tensor calculus Mechanisms of momentum transport Shell momentum balances.	Appling
CO2	1-D problems on velocity distribution in laminar flow Equations of change for isothermal systems Applications of equations of change to solve 1-D problems on velocity distribution in laminar flow.	Understanding
CO3	Transport phenomena in polymeric liquids Mechanisms of energy transport Shell energy balances.	Understanding
CO4	Mechanisms of mass transport Shell mass balances.	Understanding
CO5	Methods of solution of momentum, heat and mass transfer problems with more than one independent variable.	Understanding

Detailed Contents	BIOTRANSPORT PHENOMENON BM- 703 /4378		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Introduction to fluid mechanics, heat and mass transfer. Physical, chemical and rheological properties of blood.	7	-
II	Unified approach of momentum, heat and mass transfer. Heat Transport: Heat production in humans, Loss of heat to the environment, Heat transfer within the body	9	-
III	Transport through cell membranes: Membrane structure, composition and permeability, Osmosis, Passive diffusion, Pressure diffusion, Facilitated transport, Facilitated diffusion of oxygen in haemoglobin solutions, Active transport, Pinocytosis.	9	-
IV	Compartment modeling: Pharmacokinetic models, The one-compartment and two-compartment open models. Structure and gross operational features of the respiratory system, Gas transport mechanisms in the lungs, Oxygen and carbon dioxide transfer in the blood, Modeling oxygen uptake in the pulmonary capillaries.	10	-
V	Structure and general features of operation of kidneys, Transport mechanisms in the tubules, Pore models of the glomerular tuft, Countercurrent mechanism of urine formation, Models of nephron function, Analytical model for Henle's loop. Artificial kidney devices: Hemodialysis, types of hemodialyzers	9	-
	Total	**44**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	David O. Cooney,	An introduction to fluid, heat & mass transport process- Principles, Vol.1, Marcel Dekker Inc., New York, 1976.
2	EdwinN.	Lightfoot, Transport phenomena and living systems – Biomedical aspects of momentum and mass transport, John Wiley, 1974
3	Ronald L. Fournier,	Basic transport phenomena in biomedical engineering, Taylor Francis, 1998.

CourseTitle	**INTRODUCTION TO BIOTECHNOLOGY**
Coursecode	**BM-072/4372**

Category	Open Elective				
Schemeand Credits	L	T	P	C	Semester VII
	3	0	0	3	
Pre-requisites (ifany)	None. Desirable– Fundamental knowledge of Biology .				
Course Objectives	Examine the basic concepts of *biotechnology* and the methods used in the manipulation of nucleic acids (DNA and RNA).				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Be able to describe the components of DNA electrophoresis, and recognize patterns in a gel.	Understanding
CO2	Be able to describe the form and function of restriction enzymes (restriction endo nucleases)	Understanding
CO3	Be able to describe the process of DNA-mediated transformation of bacterial cells.	Understanding
CO4	Discuss the molecular basis for the results of a DNA- mediated transformation.	Understanding

Detailed Contents **INTRODUCTION TO BIOTECHNOLOGY BM-072/4372**

Module	Contents	L (Hours)	T (Hours)
I	Introduction: Concept nature and scope of blotechnology. Cell Structure and Function: Eukaryotic and prokaryotic cells, cell wall, membrane orgat nation, cell organelles, Nucleus, Mitrochondria, endoplasmic reticulum, chloroplast, viruses and toxins into cells.	08	-
II	Biomolecules: A brief account of structure of carbohydrates, Lipids and Proteins. Genes: Brief idea about Mendel's laws and chromosomes, nature of genetic materials, DNA and RNA, DNA replication.	09	-
III	Gene Expression: Central dogma, genetic code, molecular mechanism on mutations, regulations of gene expression, house keeping genes, differentiation and development mutations and their molecular basic. Genetic Engineering: Introduction, cloning (vectors and enzymes), DNA and genomic libraries, Transgenics, DNA fingerprinting, genomics.	11	-
IV	Applications of Biotechnology: Bioprocess and fermentation technology, cell culture, Enzyme technology, biological fuel generation, sewage treatment, environmental biotechnology, biotechnology and medicine, biotechnology in agriculture, food and beverage technology, production of biological invention.	10	-
V	Safety and Ethics: Safety, social, moral and ethic considerations, environmental ethics, bioethics and stem cell research, safety of new biotechnology foods, agro biodiversity and donor policies.	08	-
	Total	**46**	-

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Smith	Biotechnology Cambridge Press.
2	P.K. Gupta	Elements of Biotechnology
3	H. D. Kumar	Modern concepts of Biotechnology Vikas publishing House.

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**NON-CONVENTIONAL ENERGY RESOURCES**				
Coursecode	**BM-073/4373**				
Category	Open Elective				
Schemeand Credits	L	T	P	C	Semester VII
	3	0	0	3	
Pre-requisites (ifany)	None				
Course Objectives	To provide a survey of the most important renewable energy resources and the technologies for harnessing these resources within the framework of a broad range of simple to state- of -the-art energy systems.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Demonstrate the generation of electricity from various Non-Conventional sources of energy, have a working knowledge on types of fuel cells.	Applying
CO2	Estimate the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation.	Evaluation
CO3	Explore the concepts involved in wind energy conversion system by studying its components, types and performance.	Understanding
CO4	Illustrate ocean energy and explain the operational methods of their utilization.	Understanding
CO5	Acquire the knowledge on Geothermal energy.	Understanding

Detailed Contents NON-CONVENTIONAL ENERGY RESOURCES BM-073/4373			
Module	**Contents**	**L Hours**	**T Hours**
I	**Introduction:** Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. **Solar Cells:** Theory of solar cells. solar cell materials, solar cell array, solar cell power plant, limitations.	08	-
II	**Solar Thermal Energy:** Solar radiation, flat plate collectors and their materials, applications and performance, focussing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.	09	-
III	**Geothermal Energy:** Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. **Magneto-hydrodynamics (MHD):** Principle of working of MHD Power plant, performance and limitations. **Fuel cell:** Principle of working of various types of fuel cells and their working, performance and limitations.	12	-
IV	**Thermo-electrical and thermionic Conversions:** Principle of working, performance and limitations. **Wind Energy:** Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. performance and limitations of energy conversion systems.	10	-
V	**Bio-mass:** Availability of bio-mass and its conversion theory. **Ocean Thermal Energy Conversion (OTEC):** Availability, theory and working principle, performance and limitations. **Wave and Tidal Wave:** Principle of working performance and limitations. Waste cycling Plants.	09	-
	Total	**48**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	R K Rajput	"Non Conventional Energy Source and Utilization".
2	Craig Zodikoff	"Ecosystem Management and Non-Conventional Energy Sources".
3	S K Agarwal	"Non Conventional Energy System".

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**BIOINFORMATICS**				
Coursecode	**BM-032/4375**				
Category	Elective Subject-III				
Schemeand Credits	L	T	P	C	Semester VII
	3	0	0	3	
Pre-requisites (ifany)	None. Desirable– Fundamental knowledge of Basic Physics and biology .				
Course Objectives	• To manage data in such a way that it allows easy access to the existing information and to submit new entries as they are produced. • To develop technological tools that help analyze biological data.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Demonstrate the most important bioinformatics databases, perform text and sequence-based searches, and analyze the results	Understanding
CO2	Carry out gene and protein expression patterns and modeling cellular interactions and processes.	Understanding
CO3	Choose biological data, submission and retrieval it from databases and design databases to store the information.	Understanding
CO4	Apply bioinformatics and biological databases to solve in real research problems	Understanding
CO5	Illustrate the impact of bioinformatics in a global, economic, environmental, and societal context.	Understanding
CO6	Design and develop expert system for real world problems.	Understanding

Detailed Contents **BIOINFORMATICS BM-032/4375**

Module	Contents	L (Hours)	T (Hours)
I	Introduction to bioinformatics- Objectives of bioinformatics, Data integration, Data analysis, Bioinformatics data bases and tools, molecular approach verses Bioinformatics approach, Overview of Bioinfromatics applications.	08	-
II	Molecular biology and information- Basic chemistry of nucleic acids, structure of DNA, Genes, functional elements in DNA, DNA sequencing and polymerase chain reaction, cloning methodology, amino acids, protein structure and protein folding, protein function.	09	-
III	Sequence alignment- Introduction to sequence analysis, models for sequence analysis and their biological motivation, methods of alignment, usage of gap penalties and scoring matrices, tools for sequence alignments, tools for multiple sequence alignments, application of multiple alignment.	10	-
IV	Gene mapping and geme expression- Applications of gene mapping, DNA sequencing, DNA microarrays, Algorithms for gene alignment, gene prediction tools, Tools for DNA/RNA structure and function analysis.	09	-
V	Proteomics- Protein styructure visualization, protein structure prediction, Methods for protein structure for known folds, Methods for protein structure for unknown folds, Methods for structure prediction, protein analysis, tools for protein analysis.	10	-
	Total	**46**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Rastogi S.C., Namita Mendiratta, Parag Rastog.	Bioinformatics concepts, skills and applications, CBS publications.
2	Baxevanis A.D., Francis Ouellette.	Bioinformtics: A practical guide to the anlysis of genes and proteins, Wiley interscience, New York.
3	Mount David,	Bioinformtics sequence and genome analysis, Cold spring harbor laboratory press

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**BIOMEDICAL IMAGE PROCESSING LAB**				
Coursecode	**BM-751/40379**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester VII
	0	0	2	1	
Pre-requisites(ifany)	None. Desirable– Knowledge Of Basic Biomedical Image Processing				
Course Objectives	• To study the Image Processing concept. To obtain histogram equalization image. • To implement smoothing or averaging filter in spatial domain. Program for opening and closing of the image. To fill the region of interest for the image. • Program for edge detection algorithm. Program of sharpen image using gradient mask. Program for morphological operation: erosion and dilation. Program for DCT/IDCT computation.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Employ image processing and analysis techniques appropriate to medical imaging	Understanding
CO2	Perform different operations to improve the quality of medical images..	Applying
CO3	Design and implement algorithm(s) for a medical image processing application.	Understanding
CO4	Apply image processing technique to solve real health care problems	Applying

BIOMEDICAL IMAGE PROCESSING LAB BM-751/40379

1. Study of MRI Images.
2. Study of CT Scan
3. Study of Mammograms.
4. Image Analysis.
5. MATLAB Implementation.

REFERENCE BOOK:

1. Pathology and Micro Biology Manual.

Course Title	**MEDICAL SYSTEM LAB**				
Course code	**BM-752/40380**				
Category	Professional core course				
Scheme and Credits	L	T	P	C	Semester VII
	0	0	2	1	
Prerequisites (if any)	None Desirable– Basic Knowledge Hospital management laboratory.				
Course Objectives	• Explain the clinical significance of molecular laboratory procedures in diagnosis and treatment of disease and maintenance of health. • Interpret and evaluate patient results and suggest or select appropriate additional testing. • Use quality assurance principles and practices to ensure the accuracy and reliability of laboratory information. • Use the principles of method evaluation to select new techniques and instruments. • Explain and apply the major principles and practices of laboratory administration, supervision and budgeting. • Explain and apply principles of effective test utilization. • Use research methods to design, conduct and disseminate results of studies on new technologies, procedures or diagnostic correlations in molecular science. • Interpret, implement, and complying with laws, regulations and accrediting standards and guidelines of relevant governmental and non-governmental agencies.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Classify hospitals, different units and their functions in hospital.	Understanding
CO2	Demonstrate knowledge of strategic planning and decision making in the healthcare.	Analyzing
CO3	Assess and prioritize various medical and engineering services in hospital.	Evaluating
CO4	Implement information system for effective and improved healthcare delivery.	Evaluating
CO5	Apply skills for improving safety and the quality of care in hospital.	Applying
CO6	Practice professional ethics and legal issues in hospital engineering and healthcare system management.	Understanding

MEDICAL SYSTEM LAB BM-752/40380

1. pH meter : study, standardization and caliberation.
2. Calorimeter.
3. Spectrophotometer.
4. Flame photometer.
5. Hb meter.
6. Conductivity meter.
7. Study and familiarization of Laser Equipments.
8. Study of physiological pre-amplifiers.
9. Pressure measurements using physiological transducers.
10. Servicing of ECG equipments.
11. Study of vaccum tube and solid state cautery
12. Study of ventilator
13. Study of ultrasonic equipment.
14. Study of X-ray radiography system.

CourseTitle	**Industrial Training**				
Coursecode	**BM-40381**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester VII
	0	0	2	1	
Pre-requisites(ifany)	None.				
Course Objectives	• The students are to undergo training for a period of at least 16 weeks in a organization/ research institute/ biomedical industry/ hospital. The concerned department of the college must continually assess the students during the entire period of training.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Communicate with other health professionals and practice professional ethics and legal issues in workplace.	Understanding
CO2	Recognize the importance of inter-professional collaboration in healthcare	Applying
	Analyze real-time problems and advocate an appropriate problem solving methodology	Understanding
	Propose a patient-centered inter-professional health improvement plan based upon the patient‘s perceived needs.	applying

INDUSTRIAL TRAINING BM-40381

The students are required to submit a report at the end of the training. The report shall have at least 25 typewritten A4 size papers and should be supported by a certificate of satisfactorily completion of training from the industry or organization in which the training was undertaken.

This report shall be duly graded by the guide/department of the college. The students are required to give a seminar presentation based on the work carried out by them. The assessment would be based on the clarity of concepts, quality of work and open discussion.

CourseTitle	**Minor Project**				
Coursecode	**BM-40382**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester VII
	0	0	2	1	
Pre-requisites(ifany)	None.				
Course Objectives	The objective of the minor project is to provide an opportunity for students to undertake short research training outside the classroom to solve real world issues.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Express the technical ideas, strategies and methodologies	Understanding
CO2	Convert ideas of interest into a conceptual model.	Creating
CO3	Work in a group in a collaborative and productive manner.	Creating
CO4	Prepare technical report and present the oral demonstrations.	Applying
CO5	Evaluate the outcome of the project work	Understanding
CO6	Evaluate application of project work with appropriate societal consideration	Applying
CO7	Develop presentation and interpersonal communication skills through project work.	Understanding

CourseTitle	**ADVANCED BIOMEDICAL INSTRUMANTATION**				
Coursecode	**BM-041/4381**				
Category	Elective-IV				
SchemeandCredits	L	T	P	C	Semester VIII
	3	0	1	4	
Prerequisites(if any)	None. Basic knowledge of medical instrument.				
Course Objectives	1. Work professionally in one or more of the following areas: biomedical electronics, medical instrumentation, medical imaging, biomedical signal processing, rehabilitation engineering, neuroengineering, and biomaterials. 2. Achieve personal and professional success with awareness and commitment to their ethical and social responsibilities, both as individuals and in team environments. 3. Maintain and improve their technical competence through lifelong learning, including entering and succeeding in an advanced degree program in a field such as engineering, science, business, or medicine.				

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Course Outcomes

On the successful completion of the course, students will be able to

CO1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Creating
CO2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Understanding
CO3	An ability to communicate effectively with a range of audiences .	Creatiing
CO4	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Understanding
CO5	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Understanding

Detailed Contents	**ADVANCED BIOMEDICAL INSTRUMANTATION BM-041/4381**		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	Analytical equipments: Colorimeter-principles of measurement and applications, Beer-Lambert's Law in spectrometry. UV, visible and infra-red spectrophotometers. Design of monochromators, detection systems. Basic applications in Biochemical analysis-Autoanalyser. Principles and applications - atomic absorption photometer, flame photometers, densitometers, gas and liquid chromatographs. Principles of scanning and transmission electron microscopy. Principles of simple, compound and phase contrast microscopes. Centrifugeprinciples and applications. Different types of sterilization methods-autoclave. Blood cell counters: Different methods for cell counting, Coulter Counters, automatic recognition and differential counting of cells.	13	-
II	Blood Flow meters: Electromagnetic blood flow meter, ultrasonic blood flow meter, Doppler blood flow meter, NMR blood flow meter, cardiac output measurement – indicator dilution methods and impedance technique.	8	-
III	Pulmonary function analyzers: Pulmonary function measurement-spirometry, respiratory gas analyzers, pneumotachography – different types of pneumotachometers, respiratory rate meter, impedance plethysmograph / pneumograph.Blood gas analyzers: Blood pH measurement, pCO2 measurement, pO2 measurement, a complete blood gas analyzer. Different types of oximetry systems, pulse oximeter..	10	-
IV	Blood pressure and heart sound measurement: Measurement of blood pressure using sphygmomanometer instrument based on Korotkoff sound, indirect measurement of blood pressure, automated indirect measurement, and specific direct measurement techniques. Heart sound measurement – stethoscope, phonocardiograph.	10	-
V	Endoscopy: Introduction, various types of endoscopes, cystoscopes, laproscopes, fiber optic endoscopes and endoscopes with integral TV cameras.	8	-
	Total	**49**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	R. S. Khandpur.	"Handbook of Bio-Medical Instrumentation'' Tata McGraw Hill
2	Carr & Brown	"Introduction to Biomedical Equipment Technology" Pearson Education, Asia.

CourseTitle	**COMMUNICATION ENGINEERING**				
Coursecode	**BM-801 / 4384**				
Category	Professional Core Course				
Schemeand Credits	L	T	P	C	Semester VIII
	3	1	0	4	
Pre-requisites (ifany)	None. Desirable– Knowledge of Signals and Systems				
Course Objectives	The objective of this course is to impart • To expose the students to classifications of Analog Modulation Techniques • To understand the Transmitters and Receivers and Noise performances • To learn the Pulse modulation Techniques, Source & Waveform Coding • To introduce Digital Modulation Techniques and Multiplexing				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Classify the signals and Understand their mathematical analysis. Spectrum plot	Understanding
CO2	Analyze and compare different analog modulation schemes for their efficiency and bandwidth	Analysing
CO3	Analyze the behavior of a communication system in presence of noise	Analysing
CO4	Investigate pulsed modulation system and analyze their system performance.	Investigating
CO5	Investigate various multiplexing techniques.	Investigating
CO6	Evaluate different digital modulation schemes and compute the bit error performance.	Evaluating

Detailed Contents	**COMMUNICATION ENGINEERING (BM-801 / 4384)**		
Module	**Contents**	**L (Hours)**	**T (Hours)**
I	Need for modulation - Amplitude modulation – Frequency spectrum of AM wave – Representation of AM – Power relation –Frequency modulation – Frequency spectrum of FM wave –AM transmitter – FM transmitter – Super heterodyne AM receiver –FM receivers.	10	-
II	Principles of pulse modulation – sampling theorem, PAM – PWM – PPM– Conversion of PWM wave to PPM wave – Generation of PAM, PPM and PWM waves – Demodulation of PAM, PWM, PPM – An introduction to digital modulation systems – PCM, ASK, FSK and PSK	8	-
III	Microwave communication systems: advantage, block diagram of a microwave radio system, microwave radio stations- Terminal station and repeater station. Satellite Communication system: Satellite Orbits, launch vehicles, look angles, satellite parameters, satellite link model, personal communication systems- GPS services.	10	-
IV	Amount of information, Entropy, Information rate, Shannon's theorem, Channel capacity, Bandwidth and S/N trade off, Introduction to error and error correction code.	8	-
V	Cellular concept, basic cellular concept and its operation, uniqueness of mobile radio environment- Performance metrics in cellular system-Elements of cellular mobile radio-Handoff-Frequency management and channel assignment-Introduction to various cellular standards like AMPS, GSM, GPRS, IS-95A, IS-95B, CDMA-2000 and WCDMA.	10	-
	Total	**46**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	**AUTHOR**	**TITLE**
1	Roddy D and Coolen J	"Electronic Communications", Prentice Hall of India Private Limited, fourth edition, 2007
2	William C.Y. Lee,	"Mobile Cellular Telecommunication Systems", McGraw Hill International
3	Gerd Keiser	"Optical fiber Communications", McGraw Hill International Edition, Fourth edition, 2006.

CourseTitle	**TELEMEDICINE**				
Coursecode	**BM-802/4385**				
Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester VIII
	3	0	0	3	
Prerequisites(if any)	None				
Course Objectives	• The primary goal of telemedicine should be to enhance overall patient outcomes. • Whether that is driven by improved accessibility, consistent follow-up care, or simply a relaxed and focused conversation, better patient outcomes can be achieved in several ways through telemedicine, including improved access to care.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Demonstrate the types of communication and network systems used in tele health technology.	Understanding
CO2	Apply telemedicine and e-health services in professional field..	Applying
CO3	Identify the conditions for successful implementation of telemedicine and e-health systems and services.	Evaluating
CO4	Promote and introduce telemedicine and e-health services and programmes.	Understanding
CO5	Plan and contribute in the design, implementation and use of telemedicine and e health systems.	Understanding

Detailed Contents	**TELEMEDICINE BM-802/4385**

Module	Contents	L(Hours)	T (Hours)
I	Fundamental concepts – Significance, Principle, functional blocks of Telemetry and Tele control system Methods of telemetry – Electrical, Pneumatic, Hydraulic and Optical Telemetry – State of the art-Telemetry standards.	9	-
II	Clinical network, Clinical parameters, Cardiology, Dermatology, Tele-radiology, EMI emergency medicine, Gastroenterology, Homecare, Neurology, Oncology, Ophthalmology, Mental health, Tele-rehabilitation, Telepathology & Tele-surgery.	9	-
III	Use of computers in distance mode of healthcare delivery, Web technology, Satellite communication systems; hypertext, voice & image transfer protocols, Medical image scanning, Data compression and Transfer, Capturing of medical signals, Analog to digital conversion, Video conferencing, Remote sensing, Rural primary setups, Referral and Super speciality centers, Societal medico legal aspects, Networking (local, national & global).	12	-
IV	Video conferencing hardware/software, Video production, Editing and Broadcasting, Tele-medical workstations, DSL equipments, Cable modem, POTS line, Fast switches ethernet, Fiber optic equipment, Router, Hubs, Monitoring devices, Vital sign monitoring devices, Respiratory monitoring devices, Neurological monitoring devices, Video scopes, Robotics and virtual reality devices	12	-
V	Legal and ethical issues, Duty of care, Malpractice and liability, Licensure and accreditation, Security and confidentiality, Ethical standards, Intellectual property rights	8	-
	Total	**50**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	B.D. Gupta	, "Introducing Telemedicine (Applications, challenges, needs and benefits, components and infrastructure)".
2	Marilyn J.	Field, Telemedicine: A Guide to Assessing Telecommunications for Health Care, National Academic Press, 1996

Electronics materials, Web Site, etc: http://nptel.ac.in

CourseTitle	**Artificial Intelligence and its Applications in Biomedical Engineering**
Coursecode	**BM- 803/4386**

Category	Professional Core Course				
SchemeandCredits	L	T	P	C	Semester VIII
	3	0	0	4	
Pre-requisites(ifany)	None. Desirable– Basic Knowledge of Artificial Intelligence.				
Course Objectives	• AI thus has a wide application in the field of biomedical engineering. • AI can also help in carrying out repetitive tasks, which are time-consuming processes. • Tasks such as computed tomography (CT) scans, X-ray scans, analyzing different tests, data entry, etc. can be done faster and more precisely by robots.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Explain the structure and role of artificial organs and rehabilitation devices for sustaining functions...	Understanding
CO2	Describe the expected functionalities of an artificial organ, orthotics and prosthesis.	Understanding
CO3	Test and apply different types of hearing and mobility aids for the benefit of the society.	Applying
CO4	Identify available technology and recognize the user needs and benefits.	Understanding
CO5	Prioritize in technological innovations for longer, healthier and more productive lives.	Applying
CO6	Design and develop various aids for physically challenged	Evaluating

Detailed Contents Artificial Intelligence and its Applications in Biomedical Engineering
BM- 803/4386

Module	Contents	L(Hours)	T (Hours)
I	Introduction to Artificial neuron and neural networks, Feature selection. Types of learning, supervised and unsupervised learning, Supervised learning decision surfaces, Two, category separation, linearly sepanable sets, Multiple category classification problems, Relationship to neural network models, Comparison of methods, Applications.	10	-
II	Unsupervised learning, Clustering, Kohonen network and competitive learning. Hebbian learning, Adaptive resonance theory (ART), Applications..	9	-
III	Introduction, Foundation of Fuzzy systen. fuzzy systems at work: Fuzzy system design, Crisp v/s Fuzzy sets, Fuzzy sets to fuzzy event, Fuzzy logic, Practical fuzzy measures, Fuzzy set operations. properties of fuzzy sets, Fuzzification techniques, Relational inference, Compositional inference. Linguistic variables and logic operators, Inference using fuzzy variables, Fuzzy implication.	11	-
IV	Fuzzy systems and algorithms, Defuzzification, Adaptive fuzzy system algorithms, Expert systems v/s fuzzy inference engines, Basic fuzzy inference algorithm. Overalll algorithm, Input data processing, Evaluating antecedent fuzzy variables, Left hand side computations; Right hand side computations, Output processing..	11	-
V	Introduction to Genetic Algorithm, Application of Al in biomedical engineering.	8	-
	Total	**49**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Dmnna L. Hudson and Maurice B. Coten	"Neural Networks and Artificial Intelligence for Biomedical Engineering", Prentice Hall of India. Pvt. Ltd., New Delhi
2	. Riza C. Berkan and sheldon L. Trubatch..	"fuzzy systems Design Principles", Standard Publishers and Distributors, Delhi.
3	Abraham Kanded and Gideon Langholz	"Fuzzy Control Systems", CRC Press, Boca Raton.

Electronics materials, Web Site, etc: www.nptel.ac.in

CourseTitle	**TISSUE ENGINEERING**
Coursecode	**BM-042/4382**

Category	Elective IV				
SchemeandCredits	L	T	P	C	Semester VIII
	3	1	0	4	
Pre-requisites(ifany)	None. Desirable– Knowledge of basic biology Tissue				
Course Objectives	The goal of tissue engineering is to assemble functional constructs that restore, maintain, or improve damaged tissues or whole organs. Artificial skin and cartilage are examples of engineered tissues that have been approved by the FDA; however, currently they have limited use in human patient.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Classify and select biomaterials for hard and soft tissue replacement.	understanding
CO2	Characterize the complex host tissue-implant interaction and explain the probable causes of implant failure.	Applying
CO3	Analyze the design of various implants and improve the functionality.	Understanding
CO4	Evaluate the biocompatibility and toxicological screening of biomaterials.	Applying
CO5	Explain the significance, current status and future potential of tissue engineering. Demonstrate the design, fabrication and biomaterials selection criteria for tissue engineering scaffolds	Evaluating

Detailed Contents **TISSUE ENGINEERING BM-042/4382**

Module	Contents	L(Hours)	T (Hours)
I	**Introduction:** Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and invitro testing	9	-
II	**Cell culture**: Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization, Bioreactors..	9	-
III	**Molecular biology aspects**: Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers	9	-
IV	**Scaffold and transplant**: Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells: introduction, hepatopoiesis..	10	-
V	**Case study and regulatory issues**: Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.	9	-
	Total	**46**	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Clemens van Blitterswijk	, Tissue Engineering, Academic Press, 2008
2	Robert Langer & William L. Chick, Academic press	"Principles of tissue engineering, Robert. P. Lanza,
3.	Joseph D. Bronzino, CRC press.	The Biomedical Engineering –Handbook,

s materials, Web Site, etc: http://nptel.ac.in, medical guru youtube channel

Course Title	DESIGN & MODULLING IN BIOMEDICAL SYSTEM

Course code	**BM-043/4383**				
Category	Electives-IV				
Scheme and Credits	L	T	P	C	Semester VIII
	3	0	0	3	
Pre-requisites (if any)	None. Desirable–Basic Design & modelling in Biomedical System.				
Course Objectives	Purpose of a Model. Models are representations that can aid in defining, analyzing, and communicating a set of concepts. System models are specifically developed to support analysis, specification, design, verification, and validation of a system, as well as to communicate certain information.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Perform needs finding and generate design requirements for medical instruments.	Understanding
CO2	Utilize fundamental design principles, machine elements, manufacturing and assembly techniques.	Understanding
CO3	Perform risk assessment for prototyping and countermeasure development	Understanding
CO4	Appreciate the need for grounding aspects, maintenance and troubleshooting.	Evaluating
CO5	Identify the reasons for equipment failure and formulate solution	Understanding

Detailed Contents	DESIGN & MODULLING IN BIOMEDICAL SYSTEM BM-043/4383		
Module	**Contents**	**L(Hours)**	**T (Hours)**
I	**Introduction to Computer Networks**: Use and types of Computer Networks, Network Hardware and Software and Reference Models.	9	
II	**Physical Layer:** Transmission Media and Public Switched Telephone Network. **Data Link Layer:** Design Issues, Error Detection and Correction, Data Link Protocols and Protocol Verification Methods.	9	
III	**Medium Access Control Sub layer:** Channel Allocation Problem, Multiple Access Protocols, Ethernet and Wireless LANs. **Network Layer:** Network layer design issues, Routing Algorithms, Congestion Control Algorithms and Quality of Service.	10	
IV	**Transport Layer:** The Transport Service, Elements of Transport Protocols, A Simple Transport Protocol, The Internet Transport Protocols and Performance Issues. **Application Layer:** Domain Name System, Electronic Mail, World Wide Web and Multimedia.	10	
V	**Network Security:** Cryptography, Symmetric-Key Algorithms, Public-Key Algorithms, Digital Signatures and Authentication Protocols.	8	
		46	**-**

L: Lecture, T: Tutorial, P: Practical, C: Credits, CO: Course Outcomes

Suggested Books

S.N.	AUTHOR	TITLE
1	Tanenbaum And rew S	Computer Networks, Ed Pearson Education 4th Ed. (2003)
2	Kurose James F and Ross Keith W	Computer Networking" Ed Pearson Education (2002)

Course Title	**MAJOR PROJECT**				
Course code	**BM-40387**				
Category	Professional Core Course				
Scheme and Credits	L	T	P	C	Semester VIII
	0	0	12	6	
Pre-requisites(if any)	None. Desirable– Knowledge of basic Biomedical instrumentation Lab				
Course Objectives	The course is designed to make the participants capable of testing, calibration & repairing of various medical electronics equipment's.				

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Prepare a comprehensive technical project report and communicate with engineers and the community at large.	Understanding
CO2	Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.	Evaluating
CO3	Test and validate through conformance of the developed prototype and analysis the cost effectiveness.	Understanding
CO5	Work independently as well as in teams and manage a project from start to finish.	Understanding
CO6	Develop an engineering project	Understanding

(Out of 16 periods, 06 periods per week should be allotted for interaction of group with project guide and 12 periods per week should be allotted for self studies and project work.)

BUNDELKHAND

UNIVERSITY JHANSI

SYLLABUS

B.TECH. BIOMEDICAL ENGINEERING

Institute of Engineering & Technology

(2nd 3rd and 4th YEAR)

Compiled by

Er. Alok Kumar

Department of Biomedical Engineering, IET Bundelkhand University, Jhansi

Session -2022-23

2nd year III SEM

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				SUBJECT TOTAL	CREADITS
						SESSIONAL			ESE		
	THEORY SUBJECTS		**L**	**T**	**P**	**TA**	**CT**	**Total**			
1.	BM-301/2371	Fundamental of Electronic Devices	3	1	0	20	30	50	100	150	4
2.	BM-302/2372	Human Anatomy and Physiology	3	1	0	20	30	50	100	150	4
3.	BM-303/2373	Fundamentals of Networks Analysis and Synthesis	3	0	0	20	30	50	100	150	3
4.	BM-304/2374	Electronic Instrumentation and Measurements	3	0	0	20	30	50	100	150	3
5.	BM-305/2375	Biomedical Statistics	3	0	0	20	30	50	100	150	3
	PRACTICAL LABORATORY										
6.	BM-351/20376	Electronic Devices Lab	0	0	2			20	30	50	1
7.	BM-352/20377	Human Anatomy and Physiology Lab	0	0	2			20	30	50	1
8.	BM-353/20378	Network System and Analysis Lab	0	0	2			20	30	50	1
9.	BM-354/20379	Meausrement Lab	0	0	2			20	30	50	1
10.	GP-301	General Proficiency Lab	-	-	-	-	-	50	-	50	
								GRAND TOTAL			21

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				SUBJECT TOTAL	CREDITS
						SESSIONAL			ESE		
	THEORY SUBJECTS		L	T	P	TA	CT	Total			
1.	BM -401/2376	Digital Electronics	3	1	0	20	30	50	100	150	4
2.	BM-402/2377	Electronic Circuits	3	1	0	20	30	50	100	150	4
3.	BM-403/2378	Sensors and Transducers in Biomedical Instrumentation	3	0	0	20	30	50	100	150	3
4.	BM-404/23789	Signal and Systems	3	0	0	20	30	50	100	150	3
5.	BM-405/2380	Electromagnetic Field Theory	3	0	0	20	30	50	100	150	3
	PRACTICAL LABORATORY										
6.	BM-451/20381	Digital Electronics Lab	0	0	2			20	30	50	1
7.	BM-452/20382	Electronics Instruments Lab	0	0	2			20	30	50	1
8.	BM-453/20383	Sensors and Transducers Lab	0	0	2			20	30	50	1
9.	BM-454/20384	Electronics Workshop and PCB Lab	0	0	2			20	30	50	1
10.	GP-401/20385	General Proficiency	-	-	-	-	-	50	-	50	
								GRAND TOTAL			21

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				SUBJECT TOTAL	CREDITS
						SESSIONAL			ESE		
	THEORY SUBJECTS		L	T	P	TA	CT	Total			
1.	BM-501/3371	Biomedical Instrumentation	3	0	0	20	30	50	100	150	3
2.	BM-502/3372	Microprocessor & Its Application	3	0	0	10	15	25	50	75	3
3.	BM-503/3373	Integrated Circuit	3	0	0	20	30	50	100	150	3
4.	BM-504/3374	Control System	3	0	0	20	30	50	100	150	3
5.	BM-505/3375	Engineering and Managerial Economics	3	0	0	20	30	50	100	150	3
6.	BM-506/3376	Elective -I	2	0	0	10	15	25	50	75	2
	PRACTICAL LABORATORY										
7.	BM-551/30379	Biomedical Instrumentation Lab	0	0	2			25	50	75	1
8.	BM-552/30380	Microprocessor Lab	0	0	2			25	50	75	1
9.	BM-553/30381	Line Integrated Circuit Lab	0	0	2			25	50	75	1
10.	BM-554/30382	Control System Lab	0	0	2			25	50	75	1
11	BM- 30383	General Proficiency						50		50	
									GRAND TOTAL		21

3rd year V SEM

List of Subjects in Elective-I

BM-3376 Biomaterials

BM-3377 Bioelectricity

BM- 3378 Advanced Semiconductor Devices

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				SUBJECT TOTAL	CERDITS
						SESSIONAL			ESE		
	THEORY SUBJECTS		L	T	P	TA	CT	Total			
1.	BM-601/3381	Physiological control system Modelling	3	0	0	20	30	50	100	150	3
2.	BM-602/3382	Microcontroller & its Application	3	0	0	20	30	50	100	150	3
3.	BM-603/3383	Biomedical Signal Processing	3	0	0	20	30	50	100	150	3
4.	BM-604/3384	Therapeutic Instruments	3	0	0	20	30	50	100	150	3
5.	BM-605/3385	Medical Imaging Techniques	3	0	0	10	15	25	50	75	3
6	BM-021/3386	Elective-II	2	0	0	10	15	25	50	75	2
	PRACTICAL LABORATORY										
7.	BM-751/40379	PCSM Lab	0	0	2			25	50	75	1
8.	BM-752/40380	Microcontroller Lab	0	0	2			25	50	75	1
9	BM-40381	Biomedical Digital Signal Processing Lab	0	0	2			25	50	75	1
10	BM-40382	Seminar	0	0	2			75		75	1
11	BM-40383	General Proficiency						50		50	
								GRAND TOTAL			19

3rd year VI SEM

BM-3386 Biomechanics

BM-3387 Laser and Fiber Optics foe Medical Applicat

BM-3388 Embedded System in Medicine

Year 4th, Semester-VII

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				SUBJECT TOTAL	CERDITS
						SESSIONAL			ESE		
	THEORY SUBJECTS		L	T	P	TA	CT	Total			
1.	BM-071/4371	Open Elective	3	0	0	20	30	50	100	150	3
2.	BM-031/4374	Elective-III	3	0	0	20	30	50	100	150	3
3.	BM-701/4376	Biomedical Image Processing	3	0	0	20	30	50	100	150	3
4.	BM-702/4377	Hospital Management System	3	0	0	20	30	50	100	150	3
5.	BM-703/4378	Biotransport Phenomenon	3	0	0	20	30	50	100	150	3
	PRACTICAL LABORATORY										
6.	BM-751/40379	Biomedical Image Processing Lab	0	0	3			25	50	75	1
7.	BM-752/40380	Medical System Lab	0	0	6			25	50	75	1
	BM-40381	Industrial/Hospital Training	0	0	0			25	50	75	1
	BM-40382	Project	0	0	0			75		75	1
	BM-40383	General Proficiency						50		50	
									GRAND TOTAL		19

List of Subject in Open Elective

BM-4371 Operation Research

BM-4372 Introduction To Biotechnology

BM-4373 Nonconventional Energy Resources

List of Subject in Elective-II

BM-4374 Artificial Organs & Rehabilitation Engg.

BM-4375 Bioinformatics

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				SUBJECT TOTAL	CREDITS
						SESSIONAL			ESE		
	THEORY SUBJECTS		L	T	P	TA	CT	Total			
1.	BM- 041/4381	Open Elective	3	1	0	20	30	50	100	150	4
2.	BM-801/4384	Communication Engineering	3	0	0	20	30	50	100	150	3
3.	BM-802/4385	Telemedicine	3	0	0	20	30	50	100	150	3
4.	BM-803/4386	Artificial Intelligence & Its Applications In Biomedical Engineering	3	0	0	20	30	50	100	150	3
	PRACTICAL LABORATORY										

6.	BM-40387	Project	0	0	12			100	250	350	6
7.	BM-40388	General proficiency						50		50	
GRAND TOTAL											19

Year 4th, Semester-VIII

BM-4381 Advanced Biomedical Instrumentation

BM-4382 Tissue Engineering

BM-4383 Design & Modelling in Biomedical System