Dr. Babasaheb Ambedkar Technological University, Lonere.

Dr. Babasaheb Ambedkar Technological University (Established as a University of Technology in the State of Maharashtra)
(under Maharashtra Act No. XXIX of 2014)
P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra Telephone and Fax. : 02140 - 275142
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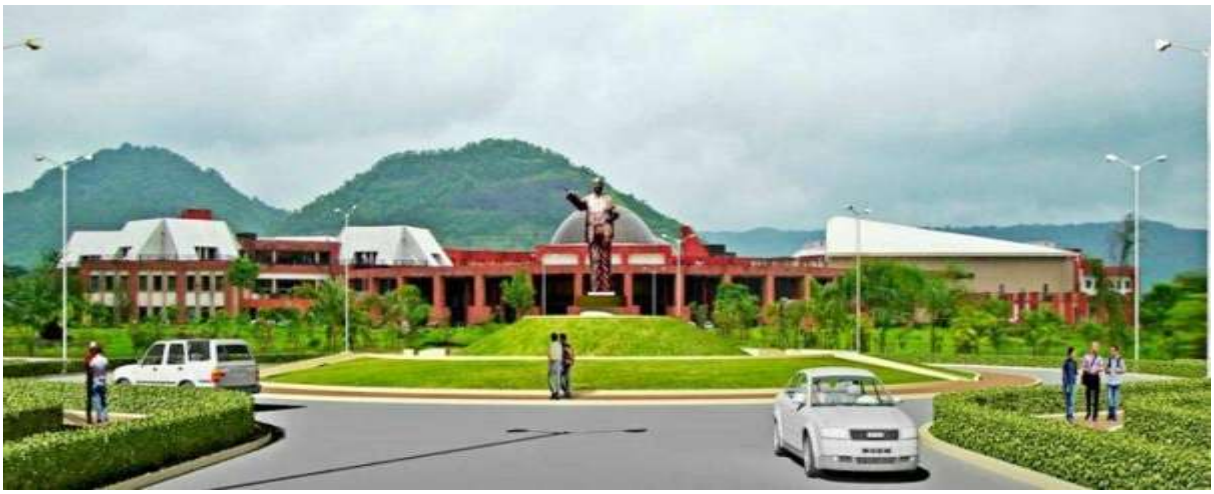
PROPOSED CURRICULUM UNDER GRADUATE PROGRAMME

B.TECH

BIOMEDICAL ENGINEERING

WITH EFFECT FROM ACADEMIC YEAR 2020-2021



Rules and Regulations

1. The normal duration of the course leading to B.Tech degree will be EIGHT semesters.
2. The normal duration of the course leading to M.Tech. degree will be FOUR semesters.
3. Each academic year shall be divided into 2 semesters, each of 20 weeks duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least 90 Teaching Days, with at least 40 hours of teaching contact periods in a five to six days session per week. The semester that is typically from Mid-July to November is called the ODD SEMESTER, and the one that is from January to Mid-May is called the EVEN SEMESTER. Academic Session may be scheduled for the Summer Session/Semester as well.For 1st year B. Tech and M. Tech the schedule will be decided as per the admission schedule declared by Government of Maharashtra.
4. The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), and announced at least TWO weeks before the Closing Date of the previous Semester.
5. The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra -curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.

REGISTRATION:

1. Lower and Upper Limits for Course Credits Registered in a Semester, by a Full-Time Student of a UG/PG Programme:

A full time student of a particular UG/PG programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that UG/PG programme as stipulated in the specific Regulations pertaining to that UG/PG programme.

2. Mandatory Pre-Registration for higher semesters:

   In order to facilitate proper planning of the academic activities of a semester, it is essential for the every institute to inform to Dean (Academics) and COE regarding details of total no. of electives offered (Course-wise) along with the number of students opted for the same. This information should be submitted within two weeks from the date of commencement of the semester as per academic calendar.
3. PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply.
4. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

Course Pre-Requisites:

1. In order to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses.

2. Students who do not register on the day announced for the purpose may be permitted LATE REGISTRATION up to the notified day in academic calendar on payment of late fee.
3. REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (Academic) / Principal.
4. A student will be permitted to register in the next semester only if he fulfills the following conditions:

(a) Satisfied all the Academic Requirements to continue with the programme of Studies without termination
(b) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
(c) Paid all required advance payments of the Institute and hostel for the current semester;
(d) Not been debarred from registering on any specific ground by the Institute.

EVALUATION SYSTEM:

1. Absolute grading system based on absolute marks as indicated below will be implementeds from academic year 2019-20,starting from I year B.Tech.

Perentage of marks	Letter grade	Grade point
91-100	EX	10.0
86-90	AA	9.0
81-85	AB	8.5
76-80	BB	8.0
71-75	BC	7.5
66-70	CC	7.0
61-65	CD	6.5
56-60	DD	6.0
51-55	DE	5.5
40-50	EE	5.0
<40	EF	0.0

2. Class is awdared based on CGPA of all eigth semster of B.Tech Program.

CGPA for pass is minimum 5.0	
CGPAupto<5.50	Pass class
CGPA ≥ 5.50 &<6.00	SecondClass
CGPA ≥ 6.00 &<7.50	First Class
CGPA ≥ 7.50	Distinction
[Percentage of Marks =CGPA*10.0]	

3. A total of 100 Marks for each theory course are distributed as follows:

	MidSemester Exam (MSE) Marks	20
	ContinuousAssesment Marks	20
	End SemesterExamination(ESE)Marks	60

4.A total of 100 Marks for each practical course are distributed as follows:

1.	Continuous Assesment Marks	60
2.	End Semester Examination (ESE)Marks	40

It is mandatory for every student of B.Tech to score a minimum of 40 marks out of 100, with a minimum of 20 marks out of 60 marks in End Semester Examination for theory course.

This will be implemented from the first year of B.Tech starting from Academic Year 2019-20

5. Description of Grades:

EX Grade: An 'EX' grade stands for outstanding achievement.
EE Grade: The 'EE' grade stands for minimum passing grade.
The students may appear for the remedial examination for the subjects he/she failed for the current semester of admission only and his/her performance will be awarded with EE grade only. If any of the student remain Absent for the regular examination due to genuine reason and the same will be verified and tested by the Dean (Academics) or committee constituted by the University Authority.
FF Grade: The 'FF' grade denotes very poor performance, i.e. failure in a course due to poor performance .The students who have been awarded 'FF' grade in a course in any semester must repeat the subject in next semester.

6. Evaluation of Performance:

1. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

(A) Semester Grade Point Average (SGPA) The performance of a student in a semester is indicated by Semester Grade Point Average (SGPA) which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SGPI is to be calculated up to two decimal places). A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{[\sum_{i=1}^{n} c_i g_i]}{[\sum_{i=1}^{n} c_i]}$$

Where
'n' is the number of subjects for the semester,
'ci' is the number of credits allotted to a particular subject, and
'gi' is the grade-points awarded to the student for the subject based on his performance as per the above table.
-SGPA will be rounded off to the second place of decimal and recorded as such.

(B) Cumulative Grade Point Average (CGPA): An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating Cumulative Grade Point Average (CGPA) of a student. The CGPA is weighted average of the grade points obtained in all the courses registered by the student since s/he entered the Institute. CGPA is also calculated at the end of every semester (upto two decimal places).Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{[\sum_{i=1}^{m} c_i g_i]}{[\sum_{i=1}^{m} c_i]}$$

Where
'm' is the total number of subjects from the first semester onwards up to and including the semester S,
'ci' is the number of credits allotted to a particular subject, and
'gi' is the grade-points awarded to the student for the subject based on his/her performance as per the above table.

-CGPA will be rounded off to the second place of decimal and recorded as such.

Award of Degree of Honours

Major Degree

The concept of Major and Minors at B.Tech level is introduced , to enhance learning skills of students, acquisition of additional knowledge in domains other than the discipline being pursued by the student, to make the students better employable with additional knowledge and encourage students to pursue cross-discipline research.

A. Eligibility Criteria for Majors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for majors has to register at the beginning of 5th Semester
3. The Student has to complete 5 additional advanced courses from the same discipline specified in the curriculum. These five courses should be of 4 credits each amounting to 20 credits. The students should complete these credits before the end of last semester.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded B.Tech (Honours) Degree.

B. Eligibility Criteria for Minors

1. The Student should have Minimum CGPA of 7.5 up to 4th Semester
2. Student willing to opt for minors has to register at the beginning of 5th Semester
3. The Student has to complete 5 additional courses from other discipline of their interest, which are specified in the respective discipline. These five courses should be of 4 credits each amounting to 20 credits.
4. Student may opt for the courses from NPTEL/ SWAYAM platform. (if the credits of NPTEL/ SWAYAM courses do not match with the existing subject proper scaling will be done)

Student complying with these criteria will be awarded with B.Tech Degree in -------Engineering with Minor in ------ --Engineering.
(For e.g.: B. Tech in Civil Engineering with Minor in Computer Engineering)

For applying for Honours and Minor Degree the student has to register themselves through the proper system.

ATTENDANCE REQUIREMENTS:

1. All students must attend every lecture, tutorial and practical classes.
2. To account for approved leave of absence (eg. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a minimum of 75% of the classes actually conducted.

If the student failed to maintain 75% attendance, he/she will be detained for appearing the successive examination.

The Dean (Academics)/ Principal is permitted to give 10% concession for the genuine reasons as such the case may be.

In any case the student will not be permitted for appearing the examination if the attendance is less than 65%.

3. The course instructor handling a course must finalize the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.
4. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

TRANSFER OF CREDITS

The courses credited elsewhere, in Indian or foreign University/Institutions/ Colleges/Swayam Courses by students during their study period at DBATU may count towards the credit requirements for the award of degree. The guidelines for such transfer of credits are as follows:

a) 20 % of the total credit will be considered for respective calculations.

b) Credits transferred will be considered for overall credits requirements of the programme.

c) Credits transfer can be considered only for the course at same level i.e UG, PG etc.

d) A student must provide all details (original or attested authentic copies)such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned Board of Studies before giving approval. The Board of Studies will then decide the number of equivalent credits the student will get for such course(s) in DBATU. The complete details will then be forwarded to Dean for approval.

e) A student has to get minimum passing grades/ marks for such courses for which the credits transfers are to be made.

f) Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.

g) In exceptional cases, the students may opt for higher credits than the prescribed.

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Department of Biomedical Engineering
Bachelor of Technology in Biomedical Engineering

Basic Science Course (BSC)

BTBS101	Engineering Mathematics- I	(3-1-0)4
BTBS102	Engineering Physics	(3-1-0)4
BTBS107L	Engineering Physics Lab	(0-0-2)1
BTBS201	Engineering Mathematics-II	(3-1-0)4
BTBS202	Engineering Chemistry	(3-1-0)4
BTBS207L	Engineering Chemistry Lab	(0-0-2)1
BTBS301	Engineering Mathematics –III	(3-1-0)4

Engineering Science Course (ESC)

BTES103	Engineering Graphics	(2-0-0)2
BTES105	Energy and Environment	(2-0-0)2
BTES106	Engineering Basic Civil & Mechanical Engineering	(2-0-0) Audit
BTES108L	Engineering Graphics Lab	(0-0-4)2
BTES203	Engineering Mechanics	(2-1-0)3
BTES204	Computer Programming	(3-0-0)3
BTES205	Workshop Practice	(0-0-4)2
BTES206	Basic Electrical and Electronics Engineering	(2-0-0) Audit
BTES208L	Engineering Mechanics Lab	(0-0-2)1
BTES304	Basics of Bio-medical Instrumentation	(3-1-0)4

Humanities and Social Science Including Management Courses (HSSMC)

BTHM104	Communication Skills	(2-0-0)2
BTHM109L	Communication Skills Lab	(0-0-2)1
BTHM403	Basic Human Rights	(3-0-0)3
BTHM605	Employability and Skill Development	(3-0-0)3
BTHM705	Engineering Economics &Financial Mathematics	(3-0-0)3
BTHM706	Foreign Language Studies	Audit

Professional Core Course (PCC)

BTBMC302	Human Anatomy and Physiology	(3-1-0)4
BTBMC303	Analog and Digital Circuits	(3-1-0)4
BTBMC305L	Human Anatomy and Physiology Lab	(0-0-2)1
BTBMC306L	Analog and Digital Circuits Lab	(0-0-4)2
BTBMC401	Biomedical Equipment	(3-1-0)4
BTBMC402	Biomedical signal Processing	(3-1-0)4
BTBMC406L	Biomedical Equipment & Biomedical signal Process Lab	(0-0-2)1
BTBMC501	Medical Image Processing	(3-1-0)4
BTBMC502	Microprocessor & Microcontroller Based Biomedical Instrumentation	(3-1-0)4
BTBMC505L	Medical Image Processing Lab	(0-0-2)1
BTBMC507L	Microprocessor & Microcontroller Based Biomedical Instrumentation Lab	(0-0-4)2
BTBMC601	Biomedical Control Systems	(3-1-0)4

BTBMC602	Microelectronics and integrated circuits	(3-1-0)4
BTBMC605L	Microelectronics and integrated circuits LAB	(0-0-4)2

Professional Elective Course (PEC)

BTBMPE404	A. Biomechanics B. Network Analysis C. Principal of Communication .System	(3-1-0)4
BTBMPE503	A. Artificial Intelligence & Neural Networks B. Rehabilitation Engineering C. Embedded & Real Time System	(3-1-0)4
BTBMPE603	A. Artificial Organs B. Applied Neural Networks &Fuzzy Logic in Medicine C. Robotics &Automation	(3-1-0)4
BTBMPE702	A. Telemedicine B. Tissue Engineering	(3-1-0)4
BTBMPE703	A.Biomaterials B. Bioelectricity	(3-1-0)4

Open Elective Course (OEC)

BTBMOE405	A. Medical Radiation Safety Engineering B. Quality Control and Regulatory Aspects in Medical Devices	(3-1-0)4
BTBMOE504	A. Applied Optoelectronics In Medicine B. Biomedical MEMS	(3-1-0)4
BTBMOE604	A. Brain-Computer Interface Development Engineering B. Electro Physiology For Human System	(3-1-0)4
BTBMOE701	A. Computational Fluid Dynamics analysis in Medicine B. Physiological System& Modeling C. Nanotechnology	(3-1-0)4
BTBMOE704	A. Nuclear Medicine B. Bio informatics	(3-1-0)4

Seminar/Mini Project/ Internship

BTES209S	Seminar	(0-0-2)1
BTES211P	Field Training / Internship /Industrial Training (minimum of 4 weeks which can be completed partially in 1sem & 2 sem or in at one time) (Internship 1)	Audit
BTBMS307	Seminar-1	(0-0-4)2
BTBMS407	Seminar2	(0-0-4)2
BTETP408	(Internship–2)	Audit
BTETM508	Mini Project–1	(0-0-4)2
BTETM607	Mini Project–2	(0-0-4)2
BTETP608	(Internship–3)	Audit
BTETM707	Mini Project–3	(0-0-4)2

Project (MP)

BTETP801	Project work/Internship	(0-0-24)12

Minor Courses (MC)

BTES304	Basics of Bio-medical Instrumentation	(3-1-0)4
BTBMC302	Human Anatomy and Physiology	(3-1-0)4

BTBMC402	Biomedical signal Processing	(3-1-0)4
BTBMC502	Microprocessor & Microcontroller Based Biomedical Instrumentation	(3-1-0)4
BTBMC601	Biomedical Control Systems	(3-1-0)4

Number of Courses	Semester							
	I	II	III	IV	V	VI	VII	VIII
1	BTBS101	BTBS201	BTBS 301	BTBMC 401	BTBMC 501	BTBMC 601	Open Elective IV	BTBMP 801 (Project/Internship)
2	BTBS102	BTBS202	BTBMC 302	BTBMC 402	BTBMC 502	BTBMC 602	Prof Elective IV	--
3	BTES103	BTES203	BTBMC 303	BTHM 403	Prof Elective II	Prof Elective III	Prof Elective V	--
4	BTHM104	BTES204	BTBMES 304	Prof. Elective I	Open Elective II	Open Elective III	Open Elective V	--
5	BTES105	BTES205	BTBMC 305L	Open Elective 1	BTBMC 505L	BTHM605	BTHM 705	--
6	BTES106	BTES206	BTBMC 306L	BTBMC 406L	BTBMC 506L	BTBMC 606L	BTHM 706	--
7	BTBS107L	BTBS207L	BTBMS 307	BTBMS407	BTBMC 507L	BTBMM 607	BTBMM 707	--
8	BTES108L	BTES208L	BTBMP 211(Internship 1 Evaluation	BTBMP408 (Internship 2)	BTBMP408 (Internship – 2 Evaluation)	BTBMP608 (Internship – 3)	BTBMP608 (Internship – 3 Evaluation)	--
9	BTHM109L	BTES209S	--	--	-	--	-	--
10	--	BTBMP211 (Internship - 1)	--	--	--	--	--	--

Degree Requirements:

Category of courses	**Minimum credits to be earned**
Basic Science Course (BSC)	**12**
Engineering Science Course (ESC)	**22**
Humanities and Social Science including Management Courses (HSSMC)	**19**
Professional Core Course (PCC)	**44**
Professional Elective Course (PEC)	**20**
Open Elective Course (OEC)	**20**
Seminar/Mini Project/ Internship/Major Project	**23**
Total	**160**

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

BIO-MEDICAL ENGINEERING

Program Educational Objectives and Outcomes

A. Program Educational Objectives (PEOs)

Graduate will –

1. To prepare our students for skilled and ethical service to their communities by creating a free and open learning environment that enhance their intellectual growth .
2. To engage our students to work in collaborative projects, corporate and academic communities in effective manner.
3. To create innovative technologies for the improvement of health care sectors and contribute positively to the needs of society.

B. Program Outcomes

Engineering Graduate will be able to –

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **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.
5. **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.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **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.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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.
12. **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 change.

C. Program Specific Outcomes (PSOs)

1. Apply advanced science and engineering to solve the problems at the interface of engineering and healthcare.
2. Demonstrate understanding of the principles and working of the hardware and software aspects of biomedical systems.
3. Use professional and ethical practices, strategies and tactics for the development, operation and maintenance of biomedical technologies.
4. Provide effective and efficient real time solutions using acquired knowledge in various domains

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

B. Tech Course in Biomedical Engineering

Curriculum for Second Year

SEMESTER III										
Course category	**Course code**	**Course title**	**Teaching scheme**			**Evaluation scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
BSC	BTBS301	Engineering Mathematics – III	3	1	-	20	20	60	100	4
PCC 1	BTBMC302	Human Anatomy and Physiology	3	1	-	20	20	60	100	4
PCC 2	BTBMC303	Analog and Digital Circuits	3	1	-	20	20	60	100	4
ESC	BTBMES304	Basics of Bio-medical Instrumentation	3	1	-	20	20	60	100	4
LC	BTBMC305L	Human Anatomy and Physiology Lab	-	-	2	60	-	40	100	2
LC	BTBMC306L	Analog and Digital Circuits Lab	-	-	4	60	-	40	100	2
Seminar	BTBMS307	Seminar-1	-	-	4	60	-	40	100	2
Internship	BTBMP211	Internship – 1 Evaluation	-	-	-	-	-	-	-	Audit
		TOTAL	**12**	**4**	**10**	**260**	**80**	**360**	**700**	**22**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course
PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course
HSSMC = Humanities and Social Science including Management Courses

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

B. Tech Course in Biomedical Engineering

Curriculum for Second Year

SEMESTER IV											
Course category	**Course code**		**Course title**	**Teaching scheme**			**Evaluation scheme**				**Credit**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 3	BTBMC401		Biomedical Equipment	3	1	-	20	20	60	100	4
PCC 4	BTBMC402		Biomedical signal Processing	3	1	-	20	20	60	100	4
HSSMC	BTHM403		Basic Human Rights	3	-	-	20	20	60	100	3
PEC 1	PRO ELE-I	BTBMPE404A	Biomechanics	3	1	-	20	20	60	100	4
		BTBMPE404B	Network Analysis								
		BTBMPE404C	Principal of Communication System								
OEC 1	OPEN ELE-I	BTBMOE405A	MedicalRadiation SafetyEngineering	3	1	-	20	20	60	100	4
		BTBMOE405B	Quality Control and Regulatory Aspects inMedical Devices								
LC	BTBMC406L		Biomedical Equipment Lab & Biomedical signal Processing Lab	-	-	4	60	-	40	100	2
Seminar	BTBMS407		Seminar 2	-	-	4	60	-	40	100	2
Internship	BTBMP408		Field Training / Internship/Industrial Training (minimum of 4 weeks which can be completed partially in third semester and fourth semester or in atone time).(Internship2)	-	-	-	-	-	-	-	Credits To be evaluated in V Sem.
			TOTAL	**15**	**4**	**8**	**220**	**100**	**380**	**700**	**23**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course
PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course
HSSMC = Humanities and Social Science including Management Courses

PROFESSIONAL ELECTIVE I

Course Code	Course Title
BTBMPE404 A	Biomechanics
BTBMPE404 B	Network Analysis
BTBMPE404 C	Principal of Communication System

OPENELECTIVE I

Course Code	Course Title
BTBMOE405 A	Medical Radiation Safety Engineering
BTBMOE405 B	Quality Control and Regulatory Aspects in Medical Devices

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

B. Tech Course in Biomedical Engineering

Curriculum for Third Year

SEMESTER V											
Course category	**Course code**		**Course title**	**Teaching scheme**			**Evaluation scheme**				**Credit**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 1	BTBMC501		Medical Image Processing	3	1	-	20	20	60	100	4
PCC 2	BTBMC502		Microprocessor and Microcontroller Based Biomedical Instrumentation	3	1	-	20	20	60	100	4
PEC 2	PRO ELE- II	BTBMPE503A	Artificial Intelligence & Neural Networks	3	1	-	20	20	60	100	4
		BTBMPE503B	Rehabilitation Engineering								
		BTBMPE503C	Embedded & Real Time System								
OEC 2	OPEN ELE-I	BTBMOE504A	Applied Optoelectronics in Medicine	3	1	-	20	20	60	100	4
		BTBMOE504B	Biomedical MEMS								
LC	BTBMC505L		Medical Image Processing LAB	-	-	2	60	-	40	100	2
LC	BTBMC506L		Microprocessor & Microcontroller Based Biomedical Instrumentation LAB	-	-	4	60	-	40	100	2
Project	BTBMM508		Mini Project – 1	-	-	4	60	-	40	100	2
Internship	BTBMP408		Internship – 2 Evaluation	-	-	-	-	-	-	-	Audit
			TOTAL	**12**	**4**	**10**	**260**	**80**	**360**	**700**	**22**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course
PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course
HSSMC = Humanities and Social Science including ManagementCourses

PROFESSIONAL ELECTIVE- II

Course Code	Course Title
BTBMPE503 A	Artificial Intelligence & Neural Networks
BTBMPE503 B	Rehabilitation Engineering
BTBMPE503 C	Embedded & Real Time System

OPEN ELECTIVE- II

Course Code	Course Title
BTBMOE504 A	Applied Optoelectronics in Medicine
BTBMOE504 B	Biomedical MEMS

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B. Tech Course in Biomedical Engineering

Curriculum for Third Year

SEMESTER VI											
Course category	**Course code**		**Course title**	**Teaching scheme**			**Evaluation scheme**				**Credit**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 1	BTBMC601		Biomedical Control Systems	3	1	-	20	20	60	100	4
PCC 2	BTBMC602		Microelectronics and integrated Circuits	3	1	-	20	20	60	100	4
PEC 3	PRO. ELE-III	BTBMPE603A	Artificial Organs	3	1	-	20	20	60	100	4
		BTBMPE603B	Applied Neural Networks and Fuzzy Logic in Medicine								
		BTBMPE603C	Robotics & Automation								
OEC 3	OPEN ELE-I	BTBMOE604A	Brain-Computer Interface Development Engineering	3	1	-	20	20	60	100	4
		BTBMOE604B	ElectroPhysiology For HumanSystem								
HSSMC	BTHM605		Employability & Skill Development	3	-	-	20	20	60	100	3
LC	BTBMC606L		Microelectronics and integrated circuits LAB	-	-	4	60	-	40	100	2
Project	BTBMM607		Mini Project 2	-	-	4	60	-	40	100	2
Internship	BTBMP608		Field Training / Internship/Industrial Training (minimum of 4 weeks which can be completed partially in third semester and fourth semester or in at one time).(Internship 3)	-	-	-	-	-	-	-	Credits To be evaluated in VII Sem.
			TOTAL	**15**	**4**	**8**	**220**	**100**	**380**	**800**	**23**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course
PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course
HSSMC = Humanities and Social Science including ManagementCourses

PROFESSIONAL ELECTIVE- III

Course Code	Course Title
BTBMPE603 A	Artificial Organs
BTBMPE603 B	Applied Neural Networks and Fuzzy Logic in Medicine
BTBMPE603 C	Robotics & Automation

OPEN ELECTIVE- III

Course Code	Course Title
BTBMOE604 A	Brain-Computer Interface Development Engineering
BTBMOE604 B	Electro Physiology For Human System

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

B. Tech Course in Biomedical Engineering

Curriculum for Fourth Year

SEMESTER VII											
Course category	**Course code**		**Course title**	**Teaching scheme**			**Evaluation scheme**				**Credit**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
OEC 4	OPEN ELE-IV	BTBMOE701 A	Computational Fluid Dynamics analysis in Medicine	3	1	-	20	20	60	100	4
		BTBMOE701 B	Physiological System & Modeling								
		BTBMOE701 C	Nano technology								
PEC 4	PROF ELE-IV	BTBMPE702 A	Telemedicine	3	1	-	20	20	60	100	4
		BTBMPE702 B	Tissue Engineering								
PEC 5	PROF ELE-V	BTBMPE703 A	Biomaterials	3	1	-	20	20	60	100	4
		BTBMPE703 B	Bioelectricity								
OEC 5	OPEN ELE-IV	BTBMOE704 A	Nuclear Medicine	3	1	-	20	20	60	100	4
		BTBMOE704 B	Bioinformatics								
HSSMC	BTHM705		Engineering Economics & Financial Mathematics	3	-	-	20	20	60	100	3
HSSMC	BTHM706		Foreign Language Studies	-	-	-	-	-	-	-	Audit
Project	BTBMM707		Mini Project - 3	-	-	4	60	-	40	100	2
Internship	BTBMP608		Internship – 3 Evaluation	-	-	-	-	-	-	-	Audit
			TOTAL	**15**	**4**	**4**	**160**	**100**	**340**	**600**	**21**

BSC = Basic Science Course, ESC = Engineering Science Course, PCC = Professional Core Course
PEC = Professional Elective Course, OEC = Open Elective Course, LC = Laboratory Course
HSSMC = Humanities and Social Science including ManagementCourses

PROFESSIONAL ELECTIVE- IV

Course Code	Course Title
BTBMPE702 A	Telemedicine
BTBMPE702 B	Tissue Engineering

OPEN ELECTIVE- IV

Course Code	Course Title
BTBMOE701 A	Computational Fluid Dynamics analysis in Medicine
BTBMOE701 B	Physiological System & Modeling
BTBMOE701 C	Nanotechnology

PROFESSIONAL ELECTIVE- V

Course Code	Course Title
BTBMPE703 A	Biomaterials
BTBMPE703 B	Bioelectricity

OPEN ELECTIVE- V

Course Code	Course Title
BTBMOE704 A	Nuclear Medicine
BTBMOE704 B	Bioinformatics

B. Tech Course in Biomedical Engineering

Curriculum for Fourth Year

SEMESTER VIII										
Course category	**Course code**	**Course title**	**Teaching scheme**			**Evaluation scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
Project/ Internship	BTBMP801	Project work/ Internship	-	-	24	60	--	40	100	12
		TOTAL	**-**	**-**	**24**	**60**		**40**	**100**	**12**

Total Credits: 160

SEMESTER III

BTBS301 ENGINEEING MATHEMATICS-III

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of appropriate solution techniques related to:

1. Linear differential equations of higher order using analytical methods and numerical methods applicable to Control systems and Networkanalysis.
2. Transforms such as Fourier transform, Laplace transform and applications to Communication systems and Signalprocessing.
3. Vector differentiation and integration required in Electromagnetics and Wavetheory.
4. Complex functions, conformal mappings, contour integration applicable to Electrostatics, Digital filters, Signal and Imageprocessing.

Course Outcomes:

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

- Solve higher order linear differential equation using appropriate techniques for modeling and analyzing electricalcircuits.
- Solve problems related to Fourier transform, Laplace transform and applications to Communication systems and Signalprocessing.
- Obtain Interpolating polynomials, numerically differentiate and integrate functions, numerical solutions of differential equations using single step and multi-step iterative methods used in modern scientificcomputing.
- Perform vector differentiation and integration, analyze the vector fields and apply to Electromagneticfields.
- Analyze conformal mappings, transformations and perform contour integration of complex functions in the study of electrostatics and signalprocessing.

Unit 1: LaplaceTransform **9 Hours**

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n, scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac deltafunction.

Unit 2: InverseLaplaceTransform **9 Hours**

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

Unit3: FourierTransform **9 Hours**

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosinetransforms ; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

Unit 4: Partial Differential Equations and Their Applications **9 Hours**

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation (), ~~an~~d one ~~dim~~ensional wave equation (i.e. —— ~~).~~—

Unit 5: Functions ofComplexVariables **9 Hours**

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs).

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, NewDelhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., NewDelhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, NewDelhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, NewYork.

2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd. , Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., NewDelhi.
4. Integral Transforms and their Engineering Applications by Dr. B. B. Singh,Synergy Knowledgeware,Mumbai.
5 Integral Transforms by I. N. Sneddon, Tata McGraw-Hill , New York.

General Instructions:

1. The tutorial classes in Engineering Mathematics-III are to be conducted batchwise. Each class should be divided into three batches for thepurpose.
2. The internal assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentageattendance.
   The minimum number of assignments should be eight covering all topics.

BTBMC302 Human Anatomy and Physiology

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	2	20	20	60	100

Course Objectives:

1. To understand clearly and identify the various parts of the human body, their anatomical position, their functions and how these can be used in the design of effective biomedicalsystems.

Course Outcomes:

- Learner will be able to learn basics of human body, cell and blood
- Learner will be able to study about the positioning and functioning of the cardio vascular system
- Learner will be able to study about the positioning and functioning of the respiratory systems and muscle tissue.
- Learner will be able to study about the positioning and functioning of the excretory and digestive system
- Learner will be able to study about the positioning and functioning of the Central Nervous System

UNIT I – Introduction to Cell& Blood **07 Hours**

Sub cellular structure and morphology, Transport across cell membranes and membrane potentials. Characteristics of Blood, Composition and function of blood, Plasma proteins, Red blood cells, White Blood cells, Physiology of Blood Clotting. Elementary Knowledge of human- skeletal system.

UNIT II – Heart(CirculatorySystem) **07 Hours**

Structure of Heart, Properties of Cardiac muscles, Cardiac Cycle, Cardiac output, Impulse generation and Transmission, Electrocardiogram, Heart sound, Regulation of Heart rate and its measurement, Regulation and Maintenance of Blood Pressure.

UNIT III - Respiratory System &MuscleTissue **07 Hours**

Anatomy of respiratory system, Pulmonary Circulation, Physiology of respiration in the alveolar and tissues Capillaries, Mechanism of Respiration, Regulation of Respiration Structure & Function of muscles, Types of muscles, Physiology of muscles contraction. Generation of action potential.

UNIT IV - Excretory System &DigestiveSystem **07 Hours**

Anatomy of urinary system and kidney, structure of kidney and urinary tracts, Nephron, Physiology of urine formation, Anatomy of digestive system, digestion and absorption of carbohydrates, Proteins and fats, Gastrointestinal tract, Role of pancreas andliver.

UNIT V – CentralNervousSystem **07 Hours**

Anatomy and function of different parts of brain, spinal cord, autonomic nervous system , Neuron, sense organ for sight and hearing.

TEXT BOOKS

1. K. Sembulingam, J.P Brothers, Essentials of MedicalPhysiology.
2. A.C. Guyton, Text Book of Medical Physiology, ElsevierSaunders.
3. William F. Ganong: Review of Medical Physioliogy, Prentice Hall InternationalInc.
4. Gerard J. Tortora and Nicholas, P. Anangnostakos: Principle of Anatomy and Physiology, Harper and Row,NewYork
5. Keele and neil: Samson Wright Applied Physiology.
6. A.J. Vander, J.H Sherman and D.C. Lucian: HumanPhysiology

BTBMC303 ANALOG AND DIGITAL CIRCUITS

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	4	20	20	60	100

Course Objectives:

1. The purpose of this course is to impart knowledge in the field of Analog & Digital Electronics and its application in the field of BiomedicalEngineering.

Course Outcomes:

- To understand the basic analog & digital logiccircuits.
- To familiarize the concepts of counters andflip-flops
- To gain knowledge about the memory organization and memorydevices
- To understand the concepts of different digital logic families for variousapplications
- To study the applications of digital systems in the medicalfield

UNITI **07 Hours**

Physical structure and equivalent circuit models (large and small signal) of diode. Zener, photo-diode, Schoktty diode, tunnel diode, power diode. Solar cell, direct band gap materials. Load line, graphical and iterative methods to obtain the current in a circuit that has a linear element like resistor and a non-linear device like diode. Rectifier circuits, Peak detector, voltage doubler, Shunt regulator using zener diodes.

UNITII **07 Hours**

Physical structure and large and small signal models of BJT. Hybrid p model with Early effect, Logic Inverter, transistor as a switch, CE amplifier, biasing network, basic current mirror, current steering circuits, improved current mirrors such as Wilson current mirror, Widlar current source, etc.BJT differential pair, CMRR, active loads, Darlington pair, cascade amplifier, BJT based input differential amplifier, intermediate stage and output stages of a typical operational amplifier.

UNITIII **07 Hours**

Physical structure and large and small signal models of MOSFETs, biasing, differential amplifier, current mirrors, improved current mirrors using MOSFETs, enhancement load device, body effect, active loads, CMOS Technology, NMOS inverter, NMOS inverter with active load, Design of CMOS inverters.

UNITIV **07 Hours**

Number-base conversion, logic gates, fundamental laws of Boolean algebra and their application in simplification of Boolean functions. K-Map , Half adder, Full adder, half subtractor, Full subtractor, Parallel Binary adder, Look Ahead carry adder, Serial adder, BCD adder. Code converter,

Magnitude Comparator. Decoder, Encoder, Multiplexer, Demultiplexer. Parity Generator & Checker

UNITV **07 Hours**

Flip-Flops & Timing Circuit, S-R Latch; D Latch; J-K flip-Flop; T Flip-Flip, S-R Flip-Flop, D Flip-Flop, Edge-triggered Flip-Flop; Master - Slave Flip-Flop; Direct Preset and Clear Inputs. PIPO, SIPO, PISO, SISO, Bi-Directional Shift Registers; Universal Shift register. Asynchronous Counter, Synchronous Counter, Up Counter, Down Counter, Ring counter, Johnson counter, Twisted Ring Counter, Effect of propagationdelay.

TEXT BOOKS

1. J. Miliman & C. Halkias Integrated electronics. Tata Mc Graw Hill.1991.
2. Albert Paul Malvino, “Electronics Principle”, Tata Mc GrawHill.
3. Bernard & Grob, “Basic Electronics”, Mc GrawHill.
4. Milliman & Gabrel, “Micro Electronics”, Tata Mc GrowHill
5. Fundamentals of Digital Circuits: A. Anand Kumar,PHI
6. Digital Integrated Electronics: H. Taub and D. Schilling:TMH

BTBMES304 Basics of BiomedicalInstrumentation

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

Course Objective:

To gain knowledge about the biological instruments and the methods of measurement.

Course Outcomes:

- Learner will be able to get the basic idea of measurements and the errors associatedwith measurement
- Learner will be able to know about the types of transducersavailable
- Learner will be able to understand the function of signal generators andanalyzers
- Learner will be able to gain knowledge on functioning of the various measuringinstruments and display devices in the application of biomedical signalrecorders

UNIT I–Transducers **07 Hours**

Classification, Selection, Resistive strain gauge, Gauge factor, Displacement, Capacitance, Inductance, Potentiometric transducers, velocity, photoelectric, photo magnetic and piezoelectric transducers. Temperature measurement, resistance thermometers. thermistors. Thermocouple and digitaltransducers.

UNIT II –PhysiologicalSignals **07 Hours**

Characteristics of ECG, EMG, EEG, PCG and instrumentation for measuring these signals. Measurement of blood flow by electromagnetic Doppler and plethymorgraphic methods.

UNIT III –Biochemical Transducers & Amplifiers forBiomedicalApplication **07 Hours**

Working Principles and characteristics of electrode, electrode–electrolyte model, half-cell potential, electrode models, microelectrodes. Patient lead device, diode circuits, diode bridge current limiters, JEET limiter, isolated leads.

UNIT IV - ClinicalLaboratoryEquipment **07 Hours**

Medical diagnosis with chemical tests, Spectrophotometry and this type of instrument, colorimeter, spectrophotometer, Automated Biochemical Analysis System, Flame photometer, Selective ion electrodes based electrolytes analyzer. Blood gas analyzer Acid –base balance, Blood Ph measurement of blood PCO2, blood PO2, Intra –arterial Blood Gas Analyzers ,Blood cell counters Types of Blood cells, Methods of cell counting, coulter counter, Automatic recognition and differential blood cellcounting.

UNIT V – Neonatal Instrument, Respiratory Measurements & Electrical Hazards 07 Hours

Incubator, Principal and techniques of impedance pneumography and pneumomotachography, Apnea monitor, study of mechanical ventilators, Nebulizers & Humdifiers, Anesthesia machine, capnograph. Safety code standards Micro and macro shock and its physiological effects. Leakage currents and protection by use of isolation transformers, equipotential grounding and earth freemonitoring.

TEXT BOOKS

1. Joseph Dubovy: Introduction to Biomedical Electronics. McGraw Hill book Company, I978
2. John G. Webster: Medical Instrumentation Application & Design Haughton Mifflin, Co. Boston. USA, I978
3. Weikowisty Etal: Biomedical Instruments – Theory and Design. Academic press.1976,
4. R.S. Khandpur: Hand Book of Biomedical Instrumentation. Tata McGraw Hill,1975.
5. L.A. Gedders & L.E. Baker: Principles of Applied Medical Instrumentation. John Wiley & Sons. NY. USA.1978

SEMESTER IV

BTBMC401 Biomedical Equipment

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	2	20	20	60	100

Course Objective:

To gain knowledge about the measuring instruments and the methods of measurement.

Course Outcomes:

- Learner will be able to get the basic idea of measurements and the errors associated with measurement
- Learner will be able to know about the types of transducersavailable
- Learner will be able to understand the function of signal generators andanalyzers
- Learner will be able to gain knowledge on functioning of the various measuring instruments and display devices in the application of biomedical signalrecorders

Unit I- Defibrillators & concepts ofcoronarycare **07 Hours**

Basics, AC defibrillators, DC defibrillators, capacitance discharge and delay line capacitance discharge, defibrillator waveforms, electrodes used with defibrillators: types and their features, Cardioverters: working, principles. Systems Organization, critical physiological characters to be monitored, and layout and safety precautions

Unit II- Cardiac pacemakers & Heartlung machine **07 Hours**

Pacemaker: Modes of operation (Asynchronous and Synchronous), External and Implantable; Block diagram and circuit diagram of a blocking oscillator asynchronous pacemaker. Implantable pacemakers: Technical and qualitative requirements of power supplies, transcutaneous RF powered Cardiac pacemaker systems, susceptibility of implantable pacemakers to electrical interference and remedial measures, Lead wires and electrodes used with pacemakers. Heart lung machine: Governing principles, qualitative requirements, functional details of bubble, thin film, and membrane type of blood oxygenator

Unit III- Electrosurgical Unit & Electrical Hazardsin hospitals **07 Hours**

Electro-surgical unit: Principles of cutting, coagulation, fulguration; Electrosurgical generators: spark gap & solid state generators, Safety features. Electrical hazards in hospitals: Patient electrical safety, types of hazards, patient isolation, physical effects of current, let go current, Micro shocks, different ways for electrical accident to occur, safety instruction circuits, electrical grounding & effects.

Unit IV - Hemodialysis&Ultrasound **07 Hours**

Hemodialysis: Qualitative requirements, general scheme of operations, types of exchangers, block diagram electronic control & monitoring Systems. Ultrasound: Characteristics of Ultrasound, Ultrasound Transducers, Different Modes of operations, Characteristics of Ultrasound beams, interaction between ultrasound and matter, design and application of real time ultrasound machine, Doppler techniques, Doppler transducer and modes of operation, colorDoppler

Unit V- X Rays, Computed Tomography & MagneticResonanceImaging **07 Hours**

x-ray: Production Of X-rays, X-rays generators, properties of X-rays, basic interaction between X-ray and matter, X-ray grids, detection of X-ray. computed tomography: Basic Principle, generations of CT scan machines, data accumulation, data handling system, component of CT scan machine, factors of image quality. magnetic resonance imaging: Principle of MRI, Elementary physics of MRI, Nuclear magnetic resonance, Magnetic field gradient, Bloch equation, Receiver-transmitter and different RF coils for MRImachines

TEXT BOOKS

1. John C. Webster, Medical Instrumentation Leighton, Mifflin Co Boston,USA
2. R. S. Khandpur Handbook of Biomedical Instrumentation, Tata McGraw hill, Pub. Co. Ltd., NewDelhi.
3. Applied Biomedical Instrumentation, La Geddes and L.E.Baker

BTBMC402 Biomedical signal Processing

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	2	20	20	60	100

Course Objectives:

1. To make them understand the fundamentals of signal processing for various bio-signalanalysis
2. To impart knowledge about filter characteristics and to design variousfilters
3. To provide an in-depth knowledge about the basic concepts of wavelet and speechanalysis
4. To apply various signal processing techniques in analyzing the various bio-signal
5. To study about the characteristics of non-stationarysignals

Course outcomes:

- To learn the fundamental concepts of signalprocessing
- To apply common signal processing techniques for various biomedicalsignals.

UNIT I – Fundamentals of Signal&System **07 Hours**

Introduction to continuous and discrete time signals and systems; Signals, types of signal, singularity functions, exponential and sinusoidal signal, sinc and signum function, gate signal, manipulation and operation on signals, Energy and power signal, System and types of system, Conversion of analog signal to digital signal, review of Fourier series and Fouriertransform.

UNIT II – Introduction and application of Z- Transform &FourierTransform **07 Hours**

Review of Z-transform, Transfer function, Frequency Response, Convolution, correlation, Power spectral Density, Autocorrelation, DTFT,DFT,FFT, Stationary and Non stationary signal, Time frequency analysis of Biomedical signals, Short term Fourier transform,Wavelet.

UNIT III – Filters & Biosignalanalysis **07 Hours**

Elements of Digital filtering, Active and Passive Filters, General Idea of L.P.F, H.P.F, B.P.F and N.F, First order Passive Filters (L.P.F, H.P.F, B.P.F and N.F), IIR and FIR Filters. EEG signal Characteristics and Analysis, ECG signal parameters and their estimation; Arrhythmia analysis monitoring; ECG data reductiontechniques.

UNIT IV – Noise analysis ofbio signal **07 Hours**

Noise Analysis and Cancellation for Biomedical Application: Source of noise, Types of Noise, Frequency domain temperature, Noise bandwidth, A Review of Weiner filter problem, Noise Analysis and Cancellation Using adaptive Filter, Adaptive Noise Canceller and its application, SignalAveraging.

UNIT V –RandomTheory **07 Hours**

Probability & Random Signal theory: set theory, introduction probability, conditional probability& statistical independence, bay's theorem, random variables, discrete random variable, continuous random variables, joint distribution, characteristics of random variables, binomial, Poisson & normal distribution, uniform & other distribution, Probability density Function and Probability Distribution Function, random processes, markovprocesses.

TEXT BOOKS:

1. Oppenheim, Wilskey and Nawab "Signals and System", Prentice HallIndia.
2. D.C.Reddy, " Biomedical Signal Processing",TMH.
3. Hayken & Van Veen- "Signals andSystem".Willey.
4. Taub & Schilling-" Principles of Communication System" , TataMcGraw-Hill.
5. Kennady & Davis –"Electronics Communication System", Tata McGrawHill.
6. Gayakwad "Op-Amp and Integrated circuits", Prentice HallIndia.

BTHM403 Basic Human Rights

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
3	3	-	-	20	20	60	100

Course Objectives:

1) To train the young minds facing the challenges of the pluralistic society and the risingconflicts and tensions in the name of particularistic loyalties to caste, religion, region andculture.
2) To give knowledge of the major "signposts" in the historical development of human rights,the range of contemporary declarations, conventions, andcovenants.
3) To enable them to understand the basic concepts of human rights (including also discrimination, equality, etc.), the relationship between individual, group, and national rights.
4) To develop sympathy in their minds for those who are deniedrights.
5) To make the students aware of their rights as well as duties to thenation.

Course Outcomes:

- Students will be able to understand the history of humanrights.
- Students will learn to respect others caste, religion, region andculture.
- Students will be aware of their rights as Indian citizen.
- Students will be able to understand the importance of groups and communities in thesociety.
- Students will be able to realize the philosophical and cultural basis and historical perspectivesof humanrights.

UNIT I:

The Basic Concepts: - Individual, group, civil society, state, equality, justice. Human Values , Human rights and Human Duties: - Origin, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people

UNIT II

Fundamental rights and economic programme. Society, religion, culture, and their inter relationship. Impact of social structure on human behavior, Social Structure and Social Problems: - Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labor.

UNIT III

Migrant workers and human rights violations, human rights of mentally and physically challenged. State, Individual liberty, Freedom and democracy. NGOs and human rights in India: - Land, Water, Forest issues.

UNIT IV

Human rights in Indian constitution and law:-
i) The constitution of India: Preamble ii) Fundamental rights. iii) Directive principles of state policy. iv) Fundamental duties. v) Some other provisions.

UNIT V

Universal declaration of human rights and provisions of India. Constitution and law. National human rights commission and state human rights commission.

Reference books:

Shastry, T. S. N., *India and Human rights: Reflections*, Concept Publishing Company India (P Ltd.), 2005
Nirmal, C.J., *Human Rights in India: Historical, Social and Political Perspectives(Law in India)*, Oxford India

PROFESSIONAL ELECTIVE –I

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMPE404A Biomechanics

Course Objectives

1. To recall the general characteristics, mechanical properties of bone andtissues.
2. To analyze the forces at joints for various static and dynamic human activities; analyze the stresses and strains in biologicaltissues.

Course Outcomes

A learner will be able to:

- Understand the definition of biomechanics and its classification and designprinciples.
- Develop a better understanding of how mechanical principles influence human motion during everydaylife.

UNIT I - BiofluidMechanics **07 Hours**

Newton's law, stress, strain, elasticity, Hooke's law, viscosity, Newtonian fluid, Non- Newtonian fluid, visco elastic fluids, Vascular tree. Relationship between diameters, Velocity and pressure of blood flow, Resistance against flow

UNIT II -CardiacMechanics **07 Hours**

Cardiovascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, and veins. Prosthetic heart valves and replacements.

UNIT III -Respiratory Mechanics **07 Hours**

Alveoli mechanics, Interaction of blood and lung, P-V curve of lung. Breathing mechanism, Airway resistance, Physics of lung diseases.

UNIT IV – SofttissueMechanics **07 Hours**

Pseudo elasticity, non-linear stress-strain relationship, viscoelasticity. Structure function and mechanical properties of skin, ligaments and tendons.

UNIT V -Orthopedic Mechanics **07 Hours**

Mechanical properties of cartilage. Diffusion properties of articular cartilage. Mechanical properties of bone. Kinetics and Kinematics of joints. Lubrication ofjoints.

TEXT BOOKS

1. Biomechanics: Y CFung
2. Basic Biomechanics: Susan B. Hall, Tata McGrawHill.
3. Fundamentals of Biomechanics: Duane Knudson,Springer.
4. Biomechanics: Principles & Applications, Donald R. Peterson & Joseph D. Bronzino, CRCPress.
5. Physics of Coronary Blood Flow: M. Zamir,Springer.

BTBMPE404B NetworkAnalysis

Course Objectives:

1. To learn about the basic laws of electric circuits as well as the key fundamentals of the communication channels, namely transmissionlines.
2. To understand the need of simplification techniques of complicatedcircuits
3. To learn about the comprehensive insight into the principle techniques available for characterizing circuits, networks and their implementation inpractice.
4. To learn about the use of mathematics, need of different transforms and usefulness of differential equations for analysis ofnetworks.
5. To train the students for handling analog filter design through theory of NA along with practical, this is basic requirement of signal processingfield.

Course Outcomes:

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

- Apply knowledge of mathematics to solve numerical based on network simplification and it will be used to analyze thesame.
- Design passive filters and attenuators theoretically and practically. To apply knowledge for design of active filters as well as digital filters and even extend this to advance adaptivefilters.
- Identify issues related to transmission of signals, analyze different RLCnetworks.
- Find technology recognition for the benefit of thesociety.

UNIT I - Network Topology & Review of loopandmode 07 Hours

Graph of a network. Concept of tree and links. Incidence matrix, Tie set & cut set schedules, solution of network, and principles of duality & network transformation. Linearly independent KVL & KCL equation. Method of analysis of DC and AC networks. Network reduction using Y-A transformations. Coupled circuits. Locus Diagram.

UNIT II- Networks theorems &Resonantcircuits 07 Hours

Reciprocity, Thevenin's, Norton's Maximum power transformation, Tellegen's and Miller's theorem. Series and parallel resonance, Frequency - response of series and parallel circuits, Q-factor, Bandwidth.

UNIT III - Transient Behavior and initial conditionsinnetworks 07 Hours

Behavior of circuit element under switching condition and their representation. Evaluation of initial and final conditions in RL, RC & RLC circuits for AC & DC excitation

UNIT IV - Transient Behavior and initial conditionsin networks 07 Hours

L.T. for Fourier transformation Definition & Properties of Laplace Transformation. Inverse Laplace transform. Partial fraction expansion, initial & final value theorem. Shifting theorem. Convolution Integral. Step, Ramp and Impulse functions. Delayed functions. Laplace transform of Periodic and non-periodicsignals.

UNIT V - One & two portnetworkparameters 07 Hours

Driving point admittance & transfer function. Pole- zero concepts of the network function. Open circuit impedance parameters, Short circuit impedance parameters, Transmission parameters, H-parameters. Calculation of these parameters for two portnetworks.

TEXT BOOKS:

1. Network Analysis, M.E. Van ValkenburgPill.
2. Network Analysis and synthesis – Fraklin F.Kuo.
3. Electric circuits: Joseph Edminister Schaum's series. Mc GrawHill.
4. R.P. Punagin : Electrical circuit theory andAnalysis.

BTBMPE404C Principal of CommunicationSystem

Course Objectives:

To impart knowledge about transmission of analog and digital information using various modulation techniques and methods of enabling secured communication.

Course Outcomes:

- Learner will be able to understand the different types of AM Communicationsystems
- Learner will be able to study in detail about the different types of FM Communicationsystems
- Learner will be able to familiarize about the base band data Communicationsystems
- Learner will be able to gain knowledge about the different digital communicationtechniques

- Learner will be able to know the spread spectrum modulation techniques and error control codingtechniques

UnitI:Amplitudemodulation **07 Hours**

Amplitude modulation systems: suppressed carrier system (DSB-SC), signals side band modulation (SSB), vestigial sideband modulation (VSM), amplitude modulation with large Carrier (AM), QAM, Generation of AM waves, de-modulation of AM waves, Frequency division multiplexing, AM Transmitters &Receivers.

Unit II:Anglemodulation **07 Hours**

Frequency Modulation (FM) & Phase Modulation (PM), Relation between FM & PM, Spectrum of FM, Narrow band FM, Wideband FM, Phasor diagram of AM & FM, FM generation & demodulation, FM transmitters & Receivers, Pre-emphasis &De-emphasis.

Unit III:pulsemodulation **07 Hours**

Sampling, Sampling theorem, Natural Sampling, Flat top sampling ,PAM, PWM, PPM, Quantization, PCM, DPCM, Delta modulation, Delta sigma modulation, Adaptive delta modulation, Time divisionmultiplexing.

Unit IV: Digitalmodulationtechniques **07 Hours**

ASK, BPSK, BFSK, DEPSK, DPSK, QPSK, QASK, MSK, M-ary FSK, M-ary PSK, Probabilty of error for ASK, BPSK, BFSK.

Unit V:Information theory&coding **07 Hours**

Information, Entropy, Information rate, Mutual Information, Channel capacity, Types of channels, Joint Entropy, Shannon theorem of channel capacity, Shannon's Hartley Theorem, Linear block codes, Cyclic codes, Shannon Fano & Huffman coding, Convolutioncodes.

TEXT BOOKS:

1. Taub& Schilling, Principle of Communication System, 2nd Ed., Tata McGrawHill.
2. Carlon, Communication System, 4th Ed. Tata McGrawHill.
3. Kennedy & Davis, Electronics Communication System, 4th Ed. Tata McGrawHill.
4. B.P. Lathi, Morden and analog Communication System, 3rd Ed. Oxford UniversityPress

OPEN ELECTIVE –I (OPEN)

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMOE405 A MEDICAL RADIATION SAFETY ENGINEERING

Course Objectives:

To impart sufficient information on the various precautionary and safety measures for radiation protection in medicine.

Course Outcomes:

- To provide an insight to the basics of radiationphysics.
- To enable them understand the guidelines of radiation protection and radiationdetectors.
- To provide information on safety measures related to UV, laser and nuclearmedicine

UNIT I - INTRODUCTION TO RF ANDMICROWAVERADIATION 07 Hours

Sources of radio frequency radiation- Effects of radio frequency radiation Development of standards for human safety- Calculation of RF field quantities- RF radiation measuring instruments and methods.

UNIT II - RADIATION DETECTIONANDMEASUREMENT 07 Hours

Fundamentals of radiation detection- Conducting radiation measurements and surveys- Gas detectors- Designing to reduce radiation hazards- Radio frequency radiation safety management and training-Scintillation detectors- Statistics of counting- minimum detectable activity- Quality assurance of radiation counters.

UNIT III - RADIATION SAFETY IN NUCLEAR MEDICINE AND RADIOTHERAPY

Design and description of NM department- Radiation protection in nuclear industry- Guidelines for radiation protection- Molecular medicine and radiation safety program-procedures for safe operation of radiation equipment- Radiation protection in external beam radiotherapy- Radiation protection in brachytherapy Radioactive wastes.

UNIT IV - LASER AND ULTRAVIOLETRADIATIONSAFETY 07 Hours

Classification of UV radiation -Sources of UV- Biological effects of UV- Hazards associated with UV radiation- UV control measures - Safety management of UV- Classifications of LASER and its radiation hazards- control measures Emergencies and incident procedures.

UNIT V - MONITORING ANDINTERNALDOSIMETRY 07 Hours

Monitoring methods-personal radiation monitoring- Records of personal dosimetry- ICRP method- MIRD method- Internal doses from radiopharmaceuticals- Bioassay of radioactivity- Hazard and risk in radiation protection- radiological incidents and emergencies- Regulation to radiationprotection.

TEXTBOOKS/ REFERENCES

1. Jamie V, Trapp, Thomas Kron, "An introduction to radiation protection in medicine", crc press Taylor &Francis group,2008.
2. Alan Martin, Samuel Harbison, Karen Beach, Peter Cole, Hodder Arnold, "An Introduction to radiation protection", 6th edition 2012.
3. Max Hlombardi, "Radiation safety in nuclear medicine", CRC Press Taylor & Francis group, 2nd edition,2007.
4. Aruna Kaushik, Anupam mondal, Dwarakanath B.S, Tripathi R P, "Radiation protection manual", INMAS, DRDO,2010.
5. Ronald kitchen, "RF and microwave radiation safety", Newness publishers, 2nd edition,2001.

BTBMOE405B QUALITY CONTROL AND REGULATORY ASPECTS IN MEDICALDEVICES

Course Objectives:

The course is designed to make the student better understanding of Quality standards and management methodologies in BiomedicalEngineering.

Course Outcomes:

- To understand the various quality standards & regulations used forhealthcare
- To get an overview of various methodologies used for management inhealthcare

UNIT I - FUNDAMENTALS OFQUALITYMANAGEMENT 07 Hours

Definition of Quality, Dimensions of Quality, Quality Planning - Quality costs. Analysis Techniques of quality Cost - Basic concepts of Total Quality Management, Historical Review. - Principles of TQM, Leadership – Concepts, Role of Senior Management - Quality Council, Quality Statements – Strategic Planning - Deming Philosophy - Barriers to TQM Implementation

UNIT II - QUALITYMANAGEMENT PRINCIPLES 07 Hours

Customer satisfaction – Customer Perception of Quality - Customer Complaints, Service Quality, Customer Retention - Employee Involvement – Motivation, Empowerment - Teams and Team Work - Recognition and Reward, Performance Appraisal, Benefits - Continuous Process Improvement – Juran Trilogy – PDSA Cycle, 5S, Kaizen - Supplier Partnership – Partnering, sourcing, Supplier, Selection, Supplier Rating, Relationship Development - Performance Measures – Basic Concepts, Strategy, PerformanceMeasure

UNIT III - STATISTICALPROCESSCONTROL 07 Hours

Seven Tools of Quality: I, II, and III - Concept of Six Sigma: I and II - New Seven Management tools: I and II - Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample - Normal Curve, Control Charts for variables and attributes, Process capability

UNIT IV -TQMTOOLS 07 Hours

Benchmarking – Reasons to Benchmark - Benchmarking Process – Quality Function Deployment (QFD) – House of Quality - QFD Process - Benefits Taguchi Quality, Loss Function - Total Productive Maintenance (TPM) – Concept, Improvement Needs - FMEA – Stages of FMEA

UNIT V - REGULATORY ORGANIZATIONSINMEDICINE 07 Hours

Need for ISO 9000 and Other Quality Systems - ISO 9000:2000 Quality System – Elements, Implementation of Quality System - Quality Auditing - Need for Accreditation of hospitals - FDA Regulations- Joint Commission – Regulatory Bodies of India-Medical Council of India - Pharmacy Council Of India, Indian Nursing Council - Dental Council of India, Homeopathy Central Council

TEXTBOOKS/ REFERENCES

1. Rose J.E, “Total Quality Management”, Kogan Page Ltd.,1993.
2. Cesar A. Cacere & Albert Zana, ”The Practise of clinical Engineering”, Academic Press, Newyork,1997.
3. John Bank, "The Essence of Total Quality Management", Prentice Hall of India,1993.
4. Webster J G, and Albert Cook M, “Clinical Engineering, Principles & Practices”, Prentice Hall Inc., Engle wood cliffs, New Jersey,1979.

SEMESTER V

BTBMC501 Medical ImageProcessing

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	2	20	20	60	100

Course Objectives:

1. To learn the image fundamentals and mathematical transforms necessary for imageprocessing
2. To study the various image enhancementtechniques
3. To apply various image restoration procedures in Medicalimages.
4. To gain knowledge about the basic concepts of image compression procedures.
5. To study about the various segmentation techniques applied to Medical Images.

Course Outcomes:

- Learner will be able to learn the fundamental concepts of medical imageacquisition
- Learner will be able to understand how to apply the image processing techniques for various medicalimages.

Unit I: Introduction&fundamentals 07 Hours

Origin of DIP, examples of fields that use DIP, fundamentals of DIP, components of an DIP system, Digital image representation, Image characteristics & quality, Image viewing conditions, Elements of visual perception, light and the EM spectrum, a simple image formation model, image sampling and quantization, some basic relationships betweenpixels.

Unit II: Image enhancement in spatial domain&frequencydomain 07 Hours

Image Enhancement in Spatial Domain: Background, some basic gray level transformations, Histogram processing, enhancement using arithmetic and logic operations, basic of spatial filtering, smoothing spatial filters, sharpening spatial filters. Image Enhancement in the Frequency Domain: Background, Introduction to FT and frequency domain, smoothing frequency domain filters, sharpening frequency domain filters, homomorphism filtering, additional properties of the 2-DFT, convolution and correlationtheorems.

Unit III:Imagecompression 07 Hours

Fundamentals, image compression models, elements of information theory, error free

Compression, run length coding, loss less predictive coding, lossy predictive coding, image compression standards, JPEG, video compression standards.

Unit IV:Imagesegmentation **07 Hours**

Detection of discontinuities, point detection, line detection, edge detection, gradient operators, edge linking and boundary detection, thresholding, region basedsegmentation.

Unit V: Image representation, description&recognition **07 Hours**

Representation, Boundary descriptors, Regional descriptors, Principal component analysis, Recognition based on decision theoretic & structuralmethods.

TEXT BOOKS

1. Digital Image Processing by Rafael .C .Gonzalez and Richard.E.
2. Digital Image Processing – by William K. Pratt 3rd Edition John Wiley and SonsInc.
3. P. Suetens, Fundamentals of image processing, Cambridge University Press,2002.
4. R. C. Gonzalez, R. E. Woods, S. L. Eddins , Digital Image Processing Using MATLAB(R) ,Course Technology, 1 edition,2004
5. A. K Jain, Fundamentals of image processing, prentice hall, Eagle cliffs, New Jersey, 1989
6. Chanda & Majumdar, Digital image processing and analysis, PHI,2003

BTBMC502 Microprocessor and Microcontroller Based Biomedical Instrumentation

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	2	20	20	60	100

Course Objectives:

1. To understand the functioning of different microprocessors and microcontrollers and to use microprocessor for various applications in biomedicalinstrumentation

Course outcomes:

- Learner will be able to study the concept of basic microprocessor8085
- Learner will be able to study the concept of microprocessor8086
- Learner will be able to get knowledge about various interfacingdevices
- Learner will be able to interface device with theprocessors
- Learner will be able to study the concept ofmicrocontroller.

UNIT I-MICROPROCESSOR-8085 **07 Hours**

Evolution & Importance of microprocessor, Microprocessor-8085: Introduction, feature, architecture, pin diagram, addressing mode, instruction set, timing diagram, interrupt- Programming exercise

UNIT II -MICROPROCESSOR-8086 **07 Hours**

Microprocessor-8086: Introduction, comparison with microprocessor-8085, feature, architecture, pin diagram, addressing mode, instruction set, minimum- and maximum- mode, assembler directives and operators, interrupts- Programming exercise

UNIT III -PERIPHERALDEVICES **07 Hours**

Interfacing: Memory- and I/O- interfacing- Programmable Peripheral Interface (PPI)-8255: Pin diagram, block diagram, and operating modes- Programmable Communication Interface (PCI)-8251 USART: Pin diagram, block diagram, and command word- Programmable Interrupt Controller (PIC)-8259A: Pin diagram, block diagram, interrupt sequence, and cascading- Keyboard/Display Controller- 8279: Pin diagram, block diagram, operating modes- DMA Controller-8237: Pin diagram, and blockdiagram

UNIT IV-MICROCONTROLLER-8051 **07 Hours**

Introduction to 8 bit microcontroller, bus configuration, reset circuitry – power down considerations, architecture of 8031/8051, Signal descriptions of 8051, Register set of 8051, Memory- and I/O Interfacing: Interrupts, instruction set, and addressing mode- Simple Programs

UNIT V - APPLICATIONSIN MEDICINE **07Hours**

Mobile phone based bio signal recording, microprocessor based vision architecture for integrated diagnostic helping devices, and Microprocessor based remote health monitoring system: Concept and systems, and system operation.

TEXTBOOKS

1. Ramesh S Gaonkar, "Microprocessor architecture, programming and its application with 8085", Penram Int. Pub. (India), Fifth edition,2002.

2. Roy A, Bhurchandi K K.M, "Intel Microprocessors Architecture, Programming and Interfacing", McGraw Hill International Second Edition2006.

REFERENCES

1. Muhammad Ali Mazidi and Janica Gilli Mazidi, "The 8051 microcontroller and embedded systems", Pearson Education, Fifth edition,2003.

2. Rafiquzzaman M, "Microprocessors - Theory and Applications" Intel and Motorola, Prentice Hall of India Pvt. Ltd, Second edition,2001.

3. Douglas V Hall, "Microprocessors and Interfacing programming and hardware", Tata McGraw Hill, Fourth Edition,2003.

PROFESSIONAL ELECTIVE-II

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMPE503A Artificial Intelligence & NeuralNetworks

Course Objectives:

1. To understand the basic concepts of Artificial intelligence and NeuralNetwork
2. To understand the concepts of knowledge representation inAI
3. To give an insight knowledge about the different types of classification techniques
4. To study about the application of AI in medicalfield

Course Outcomes:

- To enable the students to acquire knowledge about the artificial intelligence techniques and its application inmedicine

UNIT-I **07 Hours**

Introduction to Artificial Intelligence: Definition of A.I. Applications of A.I. Representation. Properties of internal Representation, General problem solving, production system, control strategies: forward and backward chaining.

UNIT-II **07 Hours**

Heuristic search techniques. Depth First Search, Breadth First Search, Best first search, mean and end analysis, A* and AO* Algorithm.

UNIT-III **07 Hours**

Knowledge representation using predicate logic: predicate calculus, Predicate and arguments, resolution and unification Semantic, Frame System, Scripts, conceptualDependency.

UNIT-IV **07 Hours**

Knowledge representation using non-monotonic logic: TMS (Truth maintenance system), statistical and probabilistic reasoning, fuzzy logic, structure knowledge representation.

UNIT-V **07 Hours**

Introduction to Artificial Neural Network, supervised and unsupervised learning, pattern recognition problems, perception, Back propagation network, Application of neural network.

TEXT BOOKS

1. Eugene, Charniak, Drew Mcdermott: Introduction to artificialintelligence.
2. Elaine Rich and Kerin Knight: ArtificialIntelligence.
3. Kishen Mehrotra, Sanjay Rawika, K Mohan; Artificial NeuralNetwork..

BTBMPE503B Rehabilitation Engineering

Course Objectives:

To learn the basic concepts of rehabilitation engineering and assist devices and to understand the importance of biomedical engineering in rehabilitation.

Course Outcomes:

- Learner will be able to study basics of RehabilitationEngineering
- Learner will be able to learn the design of WheelChairs
- Learner will be able to gain knowledge of the recent developments in the field of rehabilitationengineering.
- Learner will be able to understand various assistive technology for vision &hearing

Learner will be able to study various orthotic & prostheticdevices

UNIT-I: ENGINEERING CONCEPTS IN REHABILITATION ENGINEERING, ANTHROPOMETRY: 07Hours

Methods for Static and dynamic Measurements: Area Measurements, Measurement of characteristics and movement, Measurement of Muscular Strength and capabilities. Measurement tools and processes in Rehabilitation engineering: fundamental principles, structure, function; performance and behavior. Subjective and objective measurement methods.

UNIT-II: ERGONOMIC ASPECTS INDESIGNATINGDEVICES: 07 Hours

Introduction to Models in Process Control, Design of Information Devices, Traditional Devices, V.D.U' s, Using color, Design of Controls

UNIT-III: ENGINEERING CONCEPTS IN SENSORY REHABILITATION ENGINEERING. SENSORY AUGMEN- TATION AND SUBSTITUTION: 07Hours

Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system: Auditory augmentation, Audiometer, Hearing aids, cochlear implantation, visual auditory substitution, tactual auditory substitution, Tactual system: Tactual augmentation, Tactualsubstitution,

UNIT-IV: ORTHOPEDIC PROSTHETICS AND ORTHOTICS IN REHABILITATION:

Engineering concepts in motor rehabilitation, applications. Computer Aided Engineering in Customized Component Design. Intelligent prosthetic knee. A hierarchically controlled prosthetic

hand. A self-aligning orthotic knee joint. externally powered and controlled Orthotics and Prosthetics. FES systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

UNIT-V: COMPUTER APPLICATIONS IN REHABILITATION ENGINEERING:
Interfaces in compensation for visual perception. Improvement of orientation and mobility, Computer assisted lip reading, Brain computer interface.

TEXT BOOKS

1. Bronzino, Joseph; Handbook of biomedical engineering. 2nd edition,CRC Press,2000.

REFERENCE BOOKS

1. Horia- Nocholai Teodorecu, L.C.Jain , intelligent systems and technologies in rehabilitation engineering; CRC; December2000.
2. Robinson C.J Rehabilitation engineering. CRC press1995
3. Etienne Grandjean, Harold Oldroyd, Fitting the task to the man, Taylor & Francis, 1988
4. Principles of deadlock – deadlock prevention, detection and avoidance dining philosophers problem – example Systems.

BTBMPE503C Embedded & Real TimeSystem

Course Objectives:

To enable the students to acquire knowledge about the principles & application of embedded systems.

Course outcomes:

- Learner will be able to understand the working principle of embeddedsystems.
- Learner will be able to understand the conceptsRTOS.
- Learner will be able to understand the designtechnologies.

UNIT-I:EMBEDDEDSYSTEMS: **07 Hours**
Overview, design challenge, processor technology, IC technology, Design Technology, Trade-offs. Single purpose processors RT-level combinational logic, sequential logic (RT-level), custom single purpose processor design (RT-level), optimizing custom single purpose processors.

UNIT-II: GENERALPURPOSEPROCESSORS: **07 Hours**
Basic architecture, operation, Pipelining, Programmer's view, development environment, Application Specific Instruction-Set Processors (ASIPs) – Micro Controllers and Digital Signal Processors.

UNIT-III: STATE MACHINE AND CONCURRENTPROCESSMODELS: 07 Hours

Introduction, models Vs. languages, finite state machines with data path model (FSMD), using state machines, program state machine model (PSM), concurrent Process model, concurrent processes, communication among processes, synchronization among processes, implementation, data flow model, real-time systems. COMMUNICATION INTERFACE: Need for communication interfaces, RS232 / UART, RS422 / RS485, USB, Infrared, IEEE 1394 Firmware, Ethernet, IEEE 802.11,Bluetooth.

UNIT-IV: EMBEDDED / RTOS CONCEPTS–I: 07 Hours

Architecture of the Kernel, Tasks and Task scheduler, Interrupt service routines, Semaphores, Mutex. EMBEDDED / RTOS CONCEPTS – II: Timers, Memory Management, Priority inversion problem, Embedded operating systems Embedded Linux, Real-time operating systems, RT Linux, Handheld operating systems, WindowsCE.

UNIT-V:DESIGNTECHNOLOGY: 07 Hours

Introduction, Automation, Synthesis, Parallel evolution of compilation and synthesis, Logic Synthesis, RT synthesis, Behavioral Synthesis, Systems Synthesis and Hardware/ Software Co-Design, Verification, Hardware/Software co-simulation, Reuse of intellectual property codes.

TEXT BOOKS

1. Embedded System Design – A Unified Hardware/Software Introduction – Frank Vahid, Tony D. Givargis, John Wiley,2002.
2. Embedded / Real Time Systems – KVKK Prasad, Dreamtech Press,2005.

REFERENCE BOOKS

1. Embedded Microcomputer Systems – Jonathan W. Valvano, Brooks / Cole, ThompsonLearning.
2. An Embedded Software Primer – David E. Simon, Pearson Ed.,2005.
3. Introduction to Embedded Systems – Raj Kamal, TMS,2002.

OPEN ELECTIVE-II

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMOE504A Applied Optoelectronics inMedicine

Course Objectives:

1. To know the basics of solid state physics and understand the nature and characteristics oflight
2. To understand different light modulation techniques and the concepts and ' applications of opticalswitching
3. To study the integration process and application of opto electronic ' integrated circuits in transmitters andreceivers

Course outcomes:

- To get familiar with the different types of optical emission, detection, modulation and opto-electronic integrated circuits and theirapplications

UNIT I - LIGHT SOURCES ANDDISPLAY DEVICES 07Hours

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Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence, LED, Laser Emission, Absorption, Population Inversion, Threshold condition, Optical Feedback, Laser Modes, Classes of Lasers, Pulsed Lasers, Plasma Display, Liquid Crystal Displays, NumericDisplays'

UNIT II - OPTO-ELECTRONICDETECTIONMETHODS 07 Hours

Basic principles of opto-electronic detection, Types of Photodiodes, Thermal detector, Photo Devices, Photo conductors, Photo detectors, Detector performance, Noiseconsiderations

UNIT III -OPTOELECTRONIC MODULATOR 07 Hours

Basic principles, Analog and digital modulation, Electro-optic modulators, Magneto optic devices, Acousto-optic devices, Optical switching, Logic devices-opticalswitching,

UNIT IV - OPTICAL AMPLIFIER & OPTOELECTRONIC INTEGRATED CIRCUITS

Semiconductor optical amplifier, Erbium doped fiber amplifier, Fiber Raman Receivers, Guided wave devices, Principles of optical biosensors, Application of opto-electronic integrated circuits

UNIT V - APPLICATIONS OF OPTOELECTRONIC DEVICES **07 Hours**

Cardiovascular and intensive care sensors, FBG for strain and temperature measurement.

TEXTBOOKS

1. Wilson J and Hawkes J.F.B, *"Opto Electronics - An Introduction"*, second edition, Prentice Hall of India Pvt. Ltd., New Delhi,1998.
2. Safa O Kasap, *Optoelectronics and Photonics: Principles and practices*, firstt edition,PHI,2009.

REFERENCES

1. John G, Webster, "Medical Instrumentation application and design", JohnWiley, 3rd Edition,1997.
2. Carr Joseph J, Brown, John M, "Introduction to Biomedical equipment technology", John Wiley and sons, New York, 4th Edition,1997.

BTBMOE504B Biomedical MEMS

Course Objectives:

1. To enable the students to acquire knowledge about the principles & application of Bio MEMS.

Course outcomes:

- Learner will be able to understand the working principle ofMEMS.
- Learner will be able to understand the CMOS MEMSTechnology.
- Learner will be able to understand the concepts of Bio MEMS & its application inhealthcare.

UNIT-I:INTRODUCTION: **07 Hours**

History of MEMS, market for MEMS, overview of MEMS processes properties of silicon, a sample MEMS process. BASICS OF MICRO TECHNOLOGY: Definitions and terminology, a sample process, lithography and etching. MEMS BIOSENSORS: Bio Flow Sensors, MEMS Images. Introduction to MEMS Pro design software.

UNIT-II:MICROMACHINING: 07 Hours

Subtractive processes (wet and dry etching), additive processes (evaporation, sputtering, epitaxial growth). FUNDAMENTAL DEVICES AND PROCESSES: Basic mechanics and electrostatics for MEMS, parallel plate actuators, pull-in point, comb drives.

UNIT-III: FUNDAMENTAL DEVICESANDPROCESSES: 07Hours

More electrostatic actuators; MEMS foundries, Cronos MUMPs (multi user MEMS process). MUMPS MULTI USER MEMS PROCESS: JDS Uniphase MUMPs processing sequence and design rules. MUMPS AND SUMMIT**:** Design rules; applications; micro hinges and deployment Actuators

UNIT-IV:CMOSMEMS: 07 Hours

CMOS foundry processes, integrated IC/MEMS, MEMS post processing, applications. Clean room lab techniques: clean rooms, gowning procedures; safety, fire, toxicity; acids and bases; photolithography.

UNIT-V: MEMS PACKAGINGAND ASSEMBLY: 07 Hours

Micro-assembly: serial and parallel, deterministic and stochastic; micro-grippers: HexSil process; packaging techniques. FUTURE OF MEMS: Bio MEMS - neural implants, gene chips, diagnostic chips; MEMS in space; mechanical computers; invisible and ubiquitouscomputing.

TEXT BOOKS

1. HSU, TAI RAN, MEMS AND MICROSYSTEMS Design And Manufacture, Tata McGraw-Hill, 2002.
2. Rai-Choudhury, Prosenjit; Mems and Moems Technology and Applications SPIE2000.

SEMESTER VI

BTBMC601 Biomedical ControlSystems

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	2	20	20	60	100

Course Objectives:

1. To understand the system concepts and different mathematical modeling techniques applied in analyzing any givensystem.
2. To analyze the given system in time domain and frequencydomain.
3. To study the techniques of plotting the responses in both domain analyses using variousplots.
4. To learn the concepts of physiologicalmodeling
5. To apply these analysis to understand the biologicalsystems

Course Outcomes:

- To gain basic knowledge about the concepts of control systems and study its application in physiologicalmodeling.

Unit I-Introduction to control systems &Mathematical modeling of control system
Introduction to control system: Open loop and closed loop system and illustrations. Mathematical modeling of control system: Block diagram representation of control system; Transfer function, Block reduction techniques and Signal flow graphs. State space Analysis; AC-DC servo motors, characteristics of feedback and feed forward back controlsystem.

Unit II-Stability & Timedomain analysis 07 Hours
Stability: Concept of stability, Necessary conditions for stability, Pole-zero locations in S-plane For stability study ; Routh and Routh Herwitz stability criteria. Time domain analysis: Use of standard test signals for time response study; Time response 2ndorder system. Performance specification steady state error constants. Root locus technique concept and construction of root locus and driving stabilityinformation.

Unit III-Introduction to physiological control system & Human thermal systems 07 Hours
Introduction to physiological control system:Physiological system differential equations, Modeling the body as compartments, behavior in simple compartmental system, pharmacy kinetic model, urea distribution model, basics of zero order and first order chemical kinetic behavior. Human thermal systems: Heat production. Loss of heat to environment. Heat transfer within the body. Thermoregulation.

Unit IV-Frequencydomainanalysis **07 Hours**

Frequency domain analysis: Closed loop frequency response performance specifications; frequency response curve; Relation between time and frequency domain specification. Polar plot; Bode plots-gain margin and phase margin for stability determination. Derivation of transfer function form Bode plots. Nyquist stability Criterion-Stability and relative stability study lines using Nyquist plots.

Unit V-Respiratory models&System **07 Hours**

Respiratory models & System, Cardiovascular control system. Skeletal muscles servo mechanism Biologicalreceptors.

TEXT BOOKS

1. The Applications of control theory of physiological system. Howard T. MilhornSounders1966
2. Automatic control systems, Benjamin C.KUO, Prentice Hall, India 46th Ed.1985.
3. Biological Control systems, analysis John. H. Milsun, McGraw Hill1966.
4. Bio-Medical Engg. Principles. David Ocooney. Marcel Dekken INC. New York andBasel.

BTBMC602 Microelectronics and integratedcircuits

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	4	20	20	60	100

Course Objectives:

1. To understand characteristics of IC and Op-Amp and identify the internalstructure.
2. To introduce DC Amplifier.
3. To study various op-amp parameters and their significance forOp-Amp.
4. To analyze and identify linear and nonlinear applications ofOp-Amp.
5. To understand functionalities offilters.

Course Outcomes:

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

- Understand the characteristics of IC and Op-Amp and identify the internalstructure.
- Understand and identify DCAmplifier
- Derive and determine various performances based parameters and their significance forOp-Amp.
- Analyze and identify linear and nonlinear applications ofOp-Amp.
- Understand and verify results (levels of V & I) with hardwareimplementation.
- Understand and apply the functionalities of filters.

Unit I: Introductiontomicroelectronics **07 Hours**

Monolithic and hybrid integrated circuits - Bipolar and MOS Technology- Fabrication of active and passive components, bonding packaging. Concept of SSI, LSI, VLSI.

Unit II: Thin film & thick film technologies &differentialamplifiers **07 Hours**

Introduction to thick film and thin film technologies, resistors & capacitors, comparison- Optical integrated circuits. Differential Amplifiers: DC Amplifier- problems with straight DC amplifier- difference amplifier. Common mode and difference mode operation- CMRR- merits and demerits- use of constant current source, drift and offset problems - current mirror and itsuse.

Unit III: Introduction tooperationalamplifiers **07 Hours**

Linear Circuits using Op Amps &Non Ideal effects of Op-Amp: Internal structure & block diagram. Characteristics of idealop-amps.Inverting amplifier, non-inverting amplifier, instrumentation amplifier, adder, subtractor, log and antilog amplifier, integrator, differentiator, peak detector, precision rectifier. Offset, drift, finite gain, finite gain bandwidth products, finite CMRR , finite Ri, non-zero Ro, slew rate, effect of finite gain or inverting and non-inverting amplifiers, offset compensation, frequencycompensation.

Unit IV: Nonlinear circuits and filters using Op amps& Filters **07 Hours**

Nonlinear circuits using op-amp-comparators, multi-vibrators, function generators, Voltage regulators, functional diagram of 723 voltage regulator, IC short circuit protection. Active filters – general transfer functions, advantages, design of second order Chebychev and Butter worth filters – low pass, high pass, band pass, band stop, filters – Gyrator – negative impedance converter, filter using simulated inductance, Universal active filter (KHN) , All passfilters.

Unit V:Op-ampapplications **07 Hours**

Sample & Hold Circuits, 555 timers: principles and working, Introduction to ADC's & DAC's. Phase Locked Loop: Principle of operation, application. Analog Multiplier: Various Types and Applications.

TEXT BOOKS:

1. Clayton "OperationalAmplifiers"
2. "Operational Amplifiers" IHRDEPublications
3. "High Frequency Electronics " learning material series, ISTE, NewDelhi
4. Sergio Franco "Design with Op-Amps and Analog Integrated Circuits" MHInternational
5. K.R. Botkar, Integrated Circuit, KhannaPublication.
6. Boylestead and Nashelesky " Electronic Devices and Circuits "PHI
7. Gayakwad "Op-Amp and Integratedcircuits"

PROFESSIONAL ELECTIVE- III

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMPE603A Artificial organs

Course Objectives:

- To gain knowledge in linear models of biologicalsystems.

Course outcomes:

- Learner will be able to understand the principles and biology underlying the design of artificial organs.

UNIT-I: ARTIFICIAL HEART & CIRCULATORYASSISTDEVICES: 07 Hours

Engineering Design of artificial Heart & Circulatory Assist Devices; Detailed Design to execute the plant; Heart Assist Technology; Blood Pumps; Prosthetic Heart Valves.

UNIT-II:ARTIFICIAL KIDNEY: 07 Hours

Structure & functions of Kidney; Hemodialysis: Principle, Dialysis membrane, membrane support structure, Dialyzer effectiveness; Hem filtration; Plasma pheresis.

UNIT-III:ARTIFICIALBLOOD: 07 Hours

Blood components & characteristics; Oxygen carrying plasma expanders; Blood substitutes; Crystalloid & colloidal solutions as volume expanders; Artificial oxygen carriers; Fluoro carbons; Hemoglobin based artificial blood. COCHLEAR IMPLANT: Introduction; candidates for implant; the auditory system; the auditory periphery; theory of operation; evaluation of cochlear prosthesis; benefits & risks of implantation; the cost of implantation; the future of cochlearprosthesis.

UNIT-IV:ARTIFICIALSKIN: 07 Hours

Structure & functions of skin; Characteristics & clinical use of skin substitutes; Two conceptual stages in the treatment of massive skin loss; Skin substitutes: characteristics & uses, types of skin substitutes.

UNIT-V:ARTIFICIAL PANCREAS: 07 Hours

Structure & function of Pancreas; Endocrine pancreas & insulin secretion; Diabetes; Insulin therapy; Insulin administration systems; Insulin production systems. ARTIFICIAL LUNGS: Gas exchange systems; Cardiopulmonary Bypass; Oxygen & CO2transport; Coupling of oxygen & CO2exchange; Shear-Induced Transport Augmentation and Devices for Improved Gas Transport.

TEXT BOOKS:

1. The Biomedical Engineering Handbook, Joseph D. Bronzino, CRCpress.
   Artificial Organs, Nadey S. Hakim,Springer.

REFERENCE BOOKS:

i. Artificial Organs, Gerald E. Miller, Morgan & ClaypoolPublishers.
ii. Biomaterials Science: An Introduction to Materials in Medicine Buddy D. Ratner, Frederick J. Schoen, Allan, S. Hoffman, Jack E.Lemons

BTBMPE603B Applied Neural Networks and Fuzzy Logic in Medicine

Course Objectives:

1. To understand the basic concepts of Artificial intelligence structures and strategies
2. To understand the concepts of knowledge representation inAI
3. To study the different pattern recognition techniques and feature extraction based onclustering
4. To give an insight knowledge about the different types of classification techniques
5. To study about the application of AI in medicalfield

Course Outcomes:

- To enable the students to acquire knowledge about the artificial intelligence techniques
- To recognize the patterns and its application inmedicine.

UNIT I -ARTIFICIALINTELLIGENCE **07 Hours**

Artificial Intelligence (AI): Introduction, definition & history, Components, Problem definition- Structures and Strategies for state space search- Depth first and breadth first search- DFS with iterative deepening- Heuristic Search- Best FirstSearch - A* Algorithm- AND, OR Graphs, Problems

UNIT II - KNOWLEDGE REPRESENTATIONIN AI **07 Hours**

Propositional- and Predicate- calculus, Theorem proving by resolution, AI representational schemes- Semantic nets, Conceptual graphs: Using framesand

scripts- Production system, Rule based expert system

UNIT III - PATTERN RECOGNITION **07 Hours**

Classes, patterns & features- Pattern similarity and PR Tasks- Pattern discrimination-Feature space metrics & Covariance matrix- Feature assessment- Unsupervised clustering- Tree clustering- K-means clustering, Statistical, syntactic and descriptive approaches.

UNIT IV - CLASSIFICATION **07 Hours** Linear discriminants, Bayesian classification, Bayes rule for minimum risk, minimum error rate classification, discriminant functions, and decision surfaces, Model free technique - ROC Curve, Classifier evaluation, Back propagation learning, Competitivelearning.

UNIT V - APPLICATIONSIN MEDICINE **07 Hours**

Diagnosis of disease using AI, Biometrics: Face recognition and Gene matching- Automated drug delivery systems- Computer aided diagnosis- Mining of electronic health record- Computervision

TEXTBOOKS

1. George F Luger, "Artificial Intelligence- Structures and Strategies for Complex Problem Solving", 4/e, 2002, Pearson Education.
2. Duda and Hart P E, "Pattern classification and scene analysis", Johnwiley
3. and sons, NY,1973.

REFERENCES

1. Earl Gose, Richard Johnsonbaugh, and Steve Jost; "PatternRecognition and Image Analysis", PHI Pvte. Ltd., NewDelhi-1,1999.
2. Fu K S, "Syntactic Pattern recognition and applications", Prentice Hall, Eaglewood cliffs, N J,1982.
3. Rochard O, Duda and Hart P E, and David G Stork, "Pattern classification", 2nd Edn., John Wiley & Sons Inc.,2001.
4. Carlo Combi, Yuval Shahar; "Artificial Intelligence in Medicine" - 12th Conference - Springer.

BTBMPE603C Robotics &Automation

Course Objectives:

- To study about the basic concepts of robots and types ofrobots.
- To study about manipulators, actuators andgrippers.
- To study about various types of sensors and powersources
- To study the various applications of robot in the medicalfield.

Course Outcomes:

- To provide the basic knowledge on design, analysis, control and working principle of robotics in surgery, rehabilitation and drug delivery (Nanorobot).

UNIT-I:BASICCONCEPTS: 07 Hours

Automation and Robotics, An overview of Robotics – present and future applications, Classification by coordinate system and control system, Dynamic stabilization of Robotics. POWER SOURCES AND SENSORS: Hydraulic, Pneumatic and electric drivers – Determination HP of motor and gearing ratio, variable speed arrangements, Path Determination - Machinery Vision – Ranging – Laser – Acoustic, Magnetic Fiber Optic and TactileSensor

UNIT-II:MANUPULATORS: 07 Hours

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators. ACTUATORS AND GRIPPERS: Pneumatic, Hydraulic Actuators, Stepper Motor Control Circuits, End Effecter, Various types of Grippers, Design consideration.

UNIT-III:KINEMATICS: 07 Hours

Forward and Inverse Kinematic Problems, Solutions of Inverse Kinematic problems, Multiple Solution, Jacobian Work Envelop – Hill Climbing Techniques.

UNIT-IV:PATH PLANNING: 07 Hours

Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion – straight line motion – Robot programming, languages and software packages.

UNIT V - ROBOTICSINMEDICINE 07 Hours

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics.

TEXT BOOKS

a. Industrial Robotics / Groover M P /PearsonEdu.

b. Robotics / Fu K S/ McGrawHill.

REFERENCE BOOKS

1. Robotics, CSP Rao and V.V. Reddy, Pearson Publications (Inpress)
2. Robotics and Control / Mittal R K & Nagrath I J /TMH.
3. An Introduction to Robot Technology, / P. Coiffet and M. Chaironze / Kogam Page Ltd. 1983 London.

OPEN ELECTIVE -III

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMOE604A Brain-Computer Interface Development Engineering

Course Objectives:

1. To gain knowledge in linear models of biologicalsystems.
2. To study the hardware and software components ofBCI
3. To familiarize the concepts of the classifiers forBCI
4. To understand the feature extraction methods for classifyingBCI
5. To gain knowledge in BCI based on visually evokedpotentials

Course Outcomes:

- Learner will be able to understand the biophysical basis of non-invasive brain signals, to apply signal processing, discrimination, and classification tools to interpret these signals, and to implement these tools into a control system for a brain-computerinterface.

UNIT I - HARDWARE/SOFTWARE COMPONENTSOFBCI 07Hours

Introduction, Components and signals, Electrodes, Bio signal amplifier, Real-time processing environment, Motor imagery, P300 spelling device, SSVEP, Accuracies achieved with different BCI principles, Applications-twitter, second life, smart home control withBCI

UNIT II - APPLIED ADVANCED CLASSIFIERSFORBCI 07 Hours

Introduction, Signal processing and feature selection, Flow of the online and offline activities, Windowing, FFT, Statistical analysis procedure, Reduction of the feature space dimensionality, Neural network Classifier for BCI devices , Experimental procedures-ANN,SVM.

UNIT III - FEATURE EXTRACTION METHODS IN CLASSIFYING EEG SIGNAL FOR BCI 07 Hours

Introduction-Methods, Mutual information, Min max mutual information, Experimental setup, Data set, Results, P300-based BCI Paradigm Design- Event-Related Potentials (ERPs), P300 detection, Applications ofP300.

UNIT IV - BCI BASED ON THE FLASH ONSET ANDOFFSETVEP 07 Hours

Introduction- Methods- Peak-to-valley amplitudes in the onset and offset FVEPs,

Determination of gazed target, Usability of Transient VEPs in BCIs- VEPs, Availability of transient VEPs, Machine learningapproach

UNIT V - VISUO-MOTOR TASKS IN ABCI ANALYSIS **07 Hours**

Introduction-Visuo motor tasks, Subjects and EEG sessions-Signal processing and fuzzy estimator, Advances in Non-Invasive BCI for Control and Biometry-Beam forming BCI, EEG basedbiometry

TEXTBOOKS

1. Reza Fazel-Rezai, *"Recent Advances in Brain-Computer InterfaceSystems"*, Intech Publications, First Edition, 2011.
2. Theodre Berger W, John k Chapin et all, *"Brain computer interfaces, An International assessment of research and developmental trends"*, Springer, First Edition,2008.

REFERENCES

1. Guido Dornhege, "Toward brain-computer interfacing", MIT Press, First Edition,2007.

BTBMOE604B Electro Physiology for HumanSystem

Course Objectives:

1. To understand the basics of the cellphysiology
2. study about the electrocardiology
3. perform the electrical activity of the musclesphysiology
4. understand the function and nerve conduction study about the peripheral nervoussystem

Course outcomes:

- Learner will be to understand the concepts and methods of electrical bio physics in the diagnosis and treatment of humandiseases.

UNIT I - INTRODUCTION TOCELL PHYSIOLOGY **07 Hours**

Level of organizing the body-chemical level, cellular level, organ level, organism level-Concept of membrane potential-Membrane potential is separation opposes changes. Electrical field in cells and Organism-Electrical structure of the living organism-extracellular field and currents-passive -action potential-electrical tissue and cell suspension-single cell in external electrical field-manipulation of cellby

electric field.

UNIT II - ELECTRICALCARDIACPHYSIOLOGY **07 Hours**

Electrical activity of the heart-cardio auto rhythmic display pace maker activity, the action potential of contractile cell-ECG record is record of the overall spread electrical activity through the heart, different part of the ECG record can be correlated specific events, ECG diagnosis the abnormal events-Mechanical events of the cardiac cycle-Cardiac output itscontrol.

UNIT III - ELECTRICALMUSCLEPHYSIOLOGY **07 Hours**

Molecular basis of the skeletal muscle contraction-Skeletal muscle fibred, myosin forms thick filaments-Muscle mechanics- Group of muscle fiber, types of contraction, EMG motor unit: EMG conduction motor unit, Muscle motor unit recruitment, Muscles fiber frequency of stimulation- Types of muscles based on the ATP hydrolysis andsynthesis.

UNIT IV -NERVECONDUCTION **07 Hours**

Nerve impulse-neurotransmitter and synapse- Passive transport and den tries-active transport and Hodgkin-Huxley equation-EEG- neurotransmitter-nerve conduction of EEG signal-Simulation of action potential-excitation threshold, neuronal refractoriness, repetitive spiking-Fitzhugh-Nagumo model-action potential in earthworm nervefiber.

UNIT V - PERIPHERAL NERVOUS SYSTEM:SPECIALSENSE **07 Hours**

Pain-simulation of nociceptors elicits the perception of the pain plus motivational and emotional response. Eye: protective mechanism help of prevent eye injuries-light controlled by iris-EOG oculography measure the resting potential of retina. ENG (Electronystagmography), oculomotor evaluation-position testing-caloric simulation of the vestibularsystem.

TEXTBOOKS

1 Laura lee Sherwood, "Human Physiology from cell to system", eighth edition,2012.
2 Laura lee Sherwood, "Fundamental of Physiology of Excitable Cells",2010.

REFERENCES

1 Lionel Opie, "Heart Physiology"2009.
2 Aidley, "7he Physiology of Excitable Cells", 3rd/4 the edition, 2008. Cambridge PressJames Cal Comb, Jonathan Tran "Introductory Biophysics",2009.
3 Roland Glaser, "Biophysics an introduction", Second edition,2009.

BTHM605 Employability & SkillDevelopment

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
3	3	-	-	20	20	60	100

Course Objectives:

1. To develop analyticalabilities.
2. To develop communicationskills.
3. To introduce the students to skills necessary for getting, keeping and being successful in aprofession.
4. To expose the students to leadership and team-buildingskills.

Course Outcomes:

On completion of the course, student will be able to:

- Have skills and preparedness for aptitudetests.
- Be equipped with essential communication skills (writing, verbal andnon-verbal)
- Master the presentation skill and be ready for facinginterviews.
- Build team and lead it for problemsolving.

UNIT-I Soft Skills &Communication basics **07 Hours**

Soft skills Vs hard skills, Skills to master, Interdisciplinary relevance, Global and national perspectives on soft skills. Resume, Curriculum vitae, How to develop an impressive resume, Different formats of resume – Chronological, Functional, Hybrid, Job application or cover letter, Professional presentation- planning, preparing and delivering presentation, Technicalwriting.

UNIT-II Arithmetic andMathematicalReasoning **07 Hours**

Aspects of intelligence, Bloom taxonomy, multiple intelligence theory, Number sequence test, mental arithmetic (square and square root, LCM and HCF, speed calculation, remindertheorem).

UNIT-III Analytical Reasoning andQuantitativeAbility **07 Hours**

Matching, Selection, Arrangement, Verifications (Exercises on each of these types). Verbal aptitude (Synonym, Antonym,Analogy).

UNIT-IV GrammarandComprehension **07 Hours**

English sentences and phrases, Analysis of complex sentences, Transformation of sentences, Paragraph writing, Story writing, Reproduction of a story, Letter writing, précis writing, Paraphrasing and e-mail writing.

UNIT-V Skillsforinterviews **07 Hours**

Interviews- types of interviews, preparatory steps for job interviews, interview skill tips, Group discussion- importance of group discussion, types of group discussion, difference between group

discussion, panel discussion and debate, personality traits evaluated in group discussions, tips for successful participation in group discussion, Listening skills- virtues of listening, fundamentals of good listening, Non-verbal communication-body movement, physical appearance, verbal sounds, closeness, time.

TEXT BOOKS:

1. R. Gajendra Singh Chauhan, Sangeeta Sharma, “Soft Skills- An integrated approach to maximize personality”, ISBN: 987-81-265-5639-7, First Edition 2016, WileyWren and Martin, "English grammar and Composition", S. Chandpublications.
2. R. S. Aggarwal, "A modern approach to verbal reasoning", S. Chandpublications.
3. Philip Carter, "The Complete Book of Intelligence Test", John Willey & SonsLtd.
4. Philip Carter, Ken Russell, "Succeed at IQ test", KoganPage.
5. Eugene Ehrlich, Daniel Murphy, "Schaum’s Outline of English Grammar", McGraw Hills.
6. David F. Beer, David A. Mc Murrey, “A Guide to Writing as an Engineer”, ISBN: 978-1-118-30027-5 4th Edition, 2014, Wiley.

SEM VII

OPEN ELECTIVE – IV

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMOE701A Computational Fluid Dynamics analysis in Medicine

Course Objectives:

1. To understand the fundamentals of fluiddynamics
2. To understand the importance of CFD and numericalmethods
3. To get an insight into FEM, FDM &FVM
4. To study the fundamentals ofdiscretization
5. To know about the application of CFD in biomedicaldomain

Course outcomes:

- Leaner will be able to enable the students to acquire knowledge about Computational Fluid Dynamics which is useful in analysis & design of various fluid flow medicaldevices

UNIT I - BASIC CONCEPTS & FUNDAMENTALS OF FLUID DYNAMICS 07 Hours
Definition &properties of fluids and classification of fluids, Introduction to fluid statics & kinematics, Governing Equations of fluid motion: Langragian & Eulerian description, Reynolds transport theorem, Integral & differential forms of governing equations: mass, momentum & energy conservation equations, Euler"s Equation, Bernoulli"s Equation, Navier-Stokesequations

UNIT II - INTRODUCTION TO CFD & OVERVIEW OF NUMERICAL METHODS
Computational fluid dynamics (CFD): What, When & Why, CFD Applications, Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods, Illustrative examples of elliptic, parabolic and hyperbolicequations.

UNIT III - INTRODUCTION TO FEM, FDM&FVM 07 Hours
Finite element method (FEM) - Finite difference method (FDM)- Finite volume

method (FVM) - Its application in medicine.

UNIT IV - FUNDAMENTALSOFDISCRETIZATION **07 Hours**

Discretization principles: Pre-processing, Solution, Post-processing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Bounded-ness, Tran sportiveness, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term, Comparison of Discretizationtechniques.

UNIT V - CFDINMEDICINE **07 Hours**

Examples of Biomedical CFD applications, Case Study-1: Respiratory flow in a bifurcation- Case Study-2: CFD Analysis of blood pump - Case Study-3: Computational model of blood flow in the aorta-coronary bypassgraft.

TEXTBOOKS

1 Robert W, Fox, Philip J, Pritchard, Alan McDonald T "Introduction to Fluid Mechanics", John Wiley & Sons, Seventh Edition2009.
2 Frank M, White, "Fluid Mechanics", Tata McGraw-Hill, Singapore, Sixth Edition, 2008.
3 Goldstein J, Richard, "Fluid Mechanics Measurements", Taylor & Francis Publication, Second Edition1996.

REFERENCES

1 Chung T J, "Computational Fluid Dynamics", Cambridge University Press, 2nd Edition2010.
2 John D, Anderson, Jr, "Computational Fluid Dynamics The Basics with Applications", Tata Mcgraw Hill, First Edition2012.
3 Blazek J, "Computational Fluid Dynamics: Principles & Applications", Elsevier, 1st Edition2001.
4 Ferziger J H & Peric M, "Computational Methods for Fluid Dynamics", Springer, 3rd Edition2002.
5 Versteeg H K, & Malalasekara W, "Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Education, 2nd Edition2008.
6 Shaw C T, "Using Computational Fluid Dynamics", Prentice Hall, First Edition1992.

BTBMOE701 B Physiological System & Modeling

Course Objectives:

1. To understand the process of modeling to various physiologicalsystems.
2. To study the mathematical tools for analyzing themodel.
3. To perform time domain and frequency domain analysis of the physiological models
4. To impart knowledge on simulation techniques for analyzing thesystems.
5. To provide an in-depth knowledge on modeling of physiologicalsystem

Course Outcomes:

- To understand and gain knowledge about methods of finding solutions to biological problems using computationaltools.

UNIT-I: (07 Hours)
Feedback control system, Homeostasis, Regulatory system, servomechanism biological control systems, similarities and differences, components of living control systems. Mathematical approach, electrical analogues

UNIT-II: (07 Hours)
Introduction to various process controls like cardiac rate, blood pressure, respiratory rate, blood glucose regulation, pharmaco-modeling & drug diffusion system.

UNIT-III: **(07 Hours)**
Modeling of human thermal regulatory systems parameters involved, control system model etc. Biochemistry of digestion, type of heat loss from body, Models of heat transfer between subsystems of human body like skin and core etc and systems like within body environmentetc.

UNIT-IV (07 Hours)
Respiratory system modeling oxygen uptake by RBC and pulmonary capillaries mass balancing by lungs, gas transport mechanism of lungs and O2and CO2 transport in blood and tissues

UNIT-V (07 Hours)
Ultra filtration system, transport through cells and tubles passive diffusion, facilitated diffusion and action transport methods of waste removal. Counter current model of urine formations in enthrone, model of Henle'sloop.

TEXT BOOKS

1. Medical Engineering–Rushmeer.
2. Bio-Medical Engineering principles, David Cooney Moral dekken INC. New York andBasel.
3. Advanced Biomedical Engg. DavidCooney.
4. Regulation and Control in Physoological Systems Ibrall and Gution, Instruments Society,USA
5. The artificical kidney, Yukihito Nose, C.V. MoshyCO
6. Electronic Devices and Rehabilitation,Webster
7. Engineering in heat blood vessels, Mysers, WileyInternational
8. Engineering in Physiology, Brown & Gann Vol 1 to12

BTBMOE701C NANOTECHNOLOGY

Course Objectives:

- To enable the students to acquire knowledge about the principles & application of Biomedical Nanotechnology

Course outcomes:

- Learner will be able to study about the biomedical Nanotechnology & its application in researchdomain.
- To develop an understanding of the methods of statistics which are used to modelengineering problems.

UNIT-I: INTRODUCTIONTONANOTECHNOLOGY: 07 Hours
Background, definition , basic ideas about atoms and molecules, physics of solid state, review of properties of matter and quantummechanics

UNIT-II: PREPARATION OFNANOSTRUCTUREDMATERIALS: 07 Hours
Lithography: Nano scale lithography, Ebeam lithography, dip pen lithography, Nano sphere lithography. Sol gel technique Molecular synthesis, Self-assembly, Polymerization

UNIT-III: CHARACTERIZATION OFNANOSTRUCTUREDMATERIALS: 07 Hours
Microscopy: TEM, SEM, SPM techniques, confocal scanning microscopy, Raman microscopy-Basic principles, applicability and practice to colloidal, macromolecular and thin film systems. Sample preparation and artifacts; POLYMER FRACTIONATION TECHNIQUES: SEC, FFF, Gel electrophoresis: Basic theory, principles and practice. THERMAL ANALYSIS: Basic principles, theory and practice. Micro DSC in the study of phase behavior and conformational change MASS SPECTROMETRY OF POLYMERS: MALDI OF MS – Basic theory, principles and practice. Applicability to proteins, polyether, controlled architecture systems

UNIT-IV: CROSS-CUTTING AREAS OF APPLICATION OF NANOTECHNOLOGY:
Energy storage, Production and Conversion. Agriculture productivity enhancement Water treatment and remediation. Disease diagnosis and screening. Drug delivery systems. Food processing and storage. Air pollution and remediation. Construction. Health Monitoring. Vector and pest detection, and control. Biomedical applications. Molecular electronics. Nano photonics. Emerging trends in applications ofnanotechnology

UNIT-V: INDUSTRIAL IMPLICATIONSOFNANOTECHNOLOGY: 07 Hours
Development of carbon nanotube based composites. Nano crystalline silver Antistatic conductive coatings. Nanometric powders. Sintered ceramics. Nanoparticle ZnO and TiO2for sun barrier products. Quantum dots for biomarkers. Sensors. Molecular electronics. Other significantimplications

TEXT BOOKS

1. Guozhong Cao, “Nanostructures and Nanomaterial”, Imperial College Press,London
2. Mark Ratner and Daniel Ratner, “A Gentle Introduction to Next Big Thing”, Pearson Education2005

PROFESSIONAL ELECTIVE – IV

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMPE702A TELEMEDICINE

Course Objectives:

- To enable the students to acquire knowledge about the principles & application ofTelemedicine

Course outcomes:

- Learner will be able to study about the Telemedicine & its application in researchdomain.
- Learner will be able to study about the legal aspect ofTelemedicine.
- Learner will be able to study about the telecommunication based biomedicalsystem.

Unit I: Introductionoftelemedicine **07 Hours**

History of Telemedicine, Block diagram of telemedicine system, Definition of telemedicine, Tele health, Tele care, Origin & development of telemedicine, Scope, benefits and limitation of telemedicine.

Unit II: Communication&networks **07 Hours**

Types of information: Audio, Video, Still image, Text and Data, Fax. Types of Communication & network: PSTN, POTS, ATN, ISDN, Internet and Wireless Communications: GSM, Satellite and Micro wave, Different modulation techniques, Types of antenna depending on requirement, Integration and Operational issue: System Integration, Store and Forward operation, Real Timetelemedicine.

Unit III:Dataexchange **07 Hours**

Network Configuration, Circuit and packet switching, H.320 series (Video phone based ISBN) T.120, H.324 (Video phone based PSTN), Video Conferencing

.

Unit IV: Data security and standards& ethical and legal aspects of telemedicine 07 Hours

Data security and standards: Encryption, Cryptography, Mechanism of Encryption, Phase of Encryption. Protocols: TCP/IP, ISO-OSI, Standard to follow DICOM, HL 7 Ethical and legal aspects of telemedicine: Confidentiality and law, Patient rights and consent, access to medical records, consent treatment, intellectual property rights, jurisdictionalissue.

Unit V: Telecommunication basedbiomedicalsystems **07 Hours**

Tele-radiology system, Tele-pathology, Tele-cardiology, Tele-oncology, Tele-surgery, Tele-education andTele-Monitoring

TEXT BOOKS

1. A .C. Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons,2002
2. R. Wootton& Victor Patterson, Introduction to Telemedicine, RSM Press,2006
3. Mohan Bansal, Medical Informatics-A Primer, Tata McGraw-Hill,2003

REFERENCE BOOKS

1. Olga Ferrer-Roca & M. Sosa ludicissa, Handbook of Telemedicine, IOS Press2002
2. A. Darkins& M. Cary, Telemedicine and Telehealth: Principles, Policies, Performance and Pitfalls,Springer Publishing Company; 1 edition,2000
3. R. Latifi, Current Principles and Practices of Telemedicine and e-Health: Volume 131Studies in Health Technology and Informatics,IOS Press; 1 edition,2008

BTBMPE702B TISSUEENGINEERING

Course Objectives:

- The students obtain deeper knowledge & understanding about subject tissueengineering.

Course outcomes:

- Learner will learn about key technologies used in tissue engineering and regenerativemedicine.
- Learner will utilize the engineering design process for the identification and development of a clinically relevant strategy to restore, repair, or regeneration a dysfunctional tissue ororgan.

UNIT-I:INTRODUCTION: **07 Hours**

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 in-vitro testing.

UNIT-II:CELLCULTURE: **07 Hours**

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.

UNIT-III: MOLECULARBIOLOGYASPECTS: **07 Hours**

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.

UNIT-IV: SCAFFOLDANDTRANSPLANT: **07 Hours**

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,hematopoiesis.

UNIT-V: CASE STUDY ANDREGULATORYISSUES: 07 Hours

Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

TEXT BOOKS:

1. Clemens van Blitterswijk, Tissue Engineering, Academic Press, 2008

REFERENCES:

1. Principles of tissue engineering, Robert. P.Lanza, Robert Langer & William L. Chick, Academicpress.
2. The Biomedical Engineering Handbook, Joseph D. Bronzino, CRCpress.
3. Introduction to Biomedical Engg. , Endarle, Blanchard & Bronzino, Academicpress.
4. Tissue Engineering, B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, CRC- Taylor &Francis

PROFESSIONAL ELECTIVE-V

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMPE703A BIOMATERIALS

Course Objectives:

1. To know about the different classes of materials used inmedicine
2. To gain knowledge about the application of biomaterials inmedicine

Course outcomes:

- Learner will be able to understand the principles and application ofbiomaterials.

Unit I - PROPERTIESOFMATERIALS **07 Hours**
Bulk properties and Surface properties of Materials. Materials used in medicine: Metals; Polymers; Hydrogels; Bio-restorable and Biodegradable Materials

UNIT-II- MATERIALS USEDINMEDICINE: **07 Hours**
Fabrics; Biologically Functional Materials; Ceramics; Natural materials; Composites, thin films, grafts and coatings; Paralytic Carbon for long-term medical Implants; Porous materials; Nanobiomaterials.

UNIT-III- HOST REACTIONSTOBIOMATERIALS: **07 Hours**
Inflammation; Wound healing and the Foreign body response; Systemic toxicity and Hypersensitivity; Blood coagulation and Blood-materials Interactions; Tumor genesis. Degradation of materials in biological environment: Degradation of Polymers, Metals and Ceramics.

UNIT-IV-APPLICATIONOFBIOMATERIALS: **07 Hours**
Cardiovascular Applications; Dental implants; Adhesives and Sealants; Ophthalmologic Applications; Orthopedic Applications; Drug Delivery System; Sutures; Bio electrodes; Biomedical Sensors and Biosensors.

UNIT-V- IMPLANTSANDDEVICES: **07 Hours**
Sterilization of implants and Devices; Implants and Device failure; Implant retrieval and Evaluation. PRODUCTS AND STANDARDS: Voluntary Consensus Standards; Product Development and Regulation.

TEXT BOOKS

1. Hench L L Ethridgc E.C. Biomaterials, an interfacial approach, Academic press 1982 Biomaterials Science: An Introduction to Materials in Medicine Buddy D. Ratner, Frederick J. Schoen, Allan S. Hoffman, Jack E.Lemons

REFERENCE BOOKS

1. Bronzino J D, The biomedical engineering handbook CRCPress

BTBMPE703B BIOELECTRICITY

Course Objectives:

- To develop student with the basic knowledge about the bioelectric phenomena within the biologicalenvironment.

Course outcomes:

- To introduce the theory and methodologies to generate electric stimulation to excitabletissue within human body and to initiate an action potential on a desirednerve.

Unit I: Introduction to bioelectricity &excitablecells 07 Hours

Bioelectric Potentials and Currents: Ionic composition of excitable cells; Nernst-Planck equation; Membranestructure; Nernst potential; Parallel-conductance model, Membrane Channels: Channel structure; Biophysicalmethods for measuring channel properties; Macroscopic channel kinetics; Channel statistics; Introduction to the Hodgkin-Huxley membranemodel

Unit II: Action potentials &impulsepropagation 07 Hours

action potentials: Observing action potentials; Nonlinear membrane behavior; Origin of action potential; Resting and peak voltages; Voltage and space clamp; Hodgkin-Huxley equations; Simulation of membrane action potential; Action potential characteristics; Active transport; Calcium channels and "other" membrane models, Impulse Propagation: Core-conductor model; Cable equations; Local circuit currents during propagation; Mathematics of propagating action potentials; Numerical solutions for propagating action potentials; Propagation velocity constraint for uniform fiber; Propagation in Militated nervefibers

Unit III: Electrical Stimulation of Excitable Tissue, Extracellular fields& Neural Electrophysiology 07Hours

Electrical Stimulation of Excitable Tissue: Linear (sub threshold) response of a single spherical cells; Linear (sub threshold) response of a cylindrical fiber, Extra cellular Fields: Basic formulation; Lumped fiber source models, Neural Electrophysiology: Structure of nervous system; Sensory transducers and neurons; Neural synapses, excitation and inhibition; Neural coding andcomputation

Unit IV: Cardiac Electrophysiology&NeuromuscularJunction 07 Hours

Cardiac Electrophysiology: Electrical nature of intercellular communication; Source models; ECG measurement and analysis, Neuromuscular Junction: Structure of neuromuscular

junction; Evidence for the quintal nature of transmitter release; Poisson statistics for transmitter release; Expressions for the effect of Ca++ and Mg++ on transmitter release; Post-junction response totransmitter

Unit V: Skeletal Muscle& FunctionalElectricalStimulation 07 Hours

Skeletal Muscle: Muscle structure; Muscle contraction; Structure of Myofibril; Sliding filament theory;Excitation-contractionFunctional Electrical Stimulation:Electrodes and electrode-tissue behavior; Nerve excitation; Recruitment; Clinicalapplications

TEXT BOOKS

1. Robert Plonsey and Roger Barr, Bioelectricity, McGraw Hill, 1986.

REFERENCE BOOKS

1. Principles of Applied Biomedical Instrumentation by L. A Geddes, John Willy &Sons,1989.
2. John Webster. Medical Instrumentation.- Application and Design. John Wileyand Sons. Inc., NewYork.
Third edition 2003.
3. Plonsey Robert and Flemming David G. Bioelectrical phenomena, McGrawHill,1969.

OPEN ELECTIVE-V

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
4	3	1	-	20	20	60	100

BTBMOE704A NUCLEAR MEDICINE

Course Objective:

- To understand the fundamentals of Nuclear Medicine and learn about the instruments involved in production techniques and therapeutic uses of NuclearMedicine.

Course Outcome:

- Learner will be able to learn the basics of nuclearmedicine
- Learner will be able to study the construction and principle of operation of various nuclear medicineinstruments
- Learner will be able to have some knowledge about the characteristics and mechanisms of radiopharmaceuticals
- Learner will be able to study the diagnostics and therapeutic applications of nuclearmedicine.
- Learner will be able to have idea about the radiation safety procedures andregulations.

UNIT-I: INTRODUCTION: (06 Hours)
Basics of radioactivity: Atomic and Nuclear Structure, Radioactive radiations, Radioactive decay, Interaction of radiation with matter: directly ionizing radiation, indirectly ionizing radiation (coherent scattering, photoelectric effect, Compton Effect, pair production); Radiopharmaceuticals: Diagnostic (in vitro & in vivo) & Therapeuticuses.

UNIT-II: RADIATION DETECTION&MEASUREMENT: (06Hours)
Radiation detector: Introduction, characteristics, modes of operation, detection mechanism, Types of Radiation. Detectors: Gas-filled (Ionization chamber, proportional counter, Geiger-Muller tubes), Scintillation Detectors (PMTs, solid & liquid detector), SemiconductorDetector.

UNIT-III: NUCLEAR MEDICINEIMAGINGSYSTEM: (06Hours)
Components of imaging system: Collimators (Parallel Hole: High resolution, High & medium energy, Slant hole; Non parallel Hole: Converging & diverging, Pinhole, Fan-beam), Camera Head, Computers; Rectilinear Scanner; Single crystal scintillation camera; Multi crystal scintillation camera; Multi crystal scintillation camera; Positron Emission Tomography; Emission computedTomography.

UNIT-IV: RADIATION THERAPY: (06 Hours)
Biology of radiation therapy; Delivery of Radiotherapy: external beam, sealed source radiotherapy (branch therapy) & unsealed source radiotherapy; Radiation Modality (superficial, orthovoltagr, megavoltage); Megavoltage Radiotherapy: Cobolt-60 units & LINACs; Brachytherapy.

UNIT-V: RADIATION PROTECTION IN MEDICINE: (06 Hours)
Principles of radiation protection; Biological effects of Radiation; Radiation Dosimetry; Dose Limits; Methods of Limiting Exposure; Radiation protection in diagnostic radiology & in Radiotherapy.

TEXT BOOKS

1. Essential Nuclear Medicine Physics, Rachel A. Powsener & Edward R.Powsener.
2. Medical Imaging Physics, William R. hendee & E. Russell Ritenour,Wiley.
3. Clinical Nuclear Medicine, Hans- Jurgen Biersack & Leonard M. Freeman,Springer.

BTBMOE704B BIOINFORMATICS

Course Objective:

- To acquaint students with applications of genetic engineering like transgenic plants, animals. The objective of this course is learning and understanding basic concepts ofBioinformatics.

Course Outcome:

- Learner will be able to learn the basics concepts ofBioinformatics
- Learner will be able to study the principle of operation of various tools used inBioinformatics.

Unit I: IntroductiontoBioinformatics (06 Hours)
Introduction to Bioinformatics: Data bank: Protein and Nucleic acid; data bank for different organisms. Use of databases in biology, sequence databases, structuraldatabases.

Unit II:SequenceAlignment (06Hours)
Sequence Alignment: Sequence analysis: protein and nucleic acids, Analysis tools for sequences Databank; Pair wise and Multiple sequence alignment; secondary structure predictions; Fold recognition, FASTA-BLAST-Amino acid substitution matrices PAM and BLOSSUM.

Unit III: Projectsanddatabases (06Hours)
Projects and databases: Structural comparisons, genome projects, Biological Information-Database location and organization; access to database; software; database searching; locating specific entries; identity searches; similarity searches

Unit IV: Information theoryandbiology (06 Hours)

Information theory and biology: Entropy, Shannon's formula, divergences, probability and independence, Markov chains, ergodic processes, redundancy, application to DNA and protein sequences

Unit V: DNA Mappingand sequencing: (06 Hours)

DNA Mapping and sequencing: Map alignment: Large scale sequencing and alignment, Shotgun-DNA sequencing, Sequence assembly, Gene predictions, Molecular predictions with DNAstrings.

TEXT BOOKS

1. Molecular databases for protein sequence and structure studies by Sillince, JA and Sillince M (1991) springerVerlag.
2. Sequence Analysis primer by M. Gribskov, J. Devereux (1989) StocktonPress.
3. Computational Methods in Mol.Biol./.Now Comprehensive Biochemistry Vol.32.S.L.Seizberg, DB Searls, S.Kasif Elsevier1998.
4. Computer methods for macromolecular analysis.Methods in Enzymology. Vol.266 byR. F. Doolittle. Academic Press 1996.
5. Information theory and living systems by L.I. Garfield, (1992) Columbia UniversityPress.
6. Dan Gusfield, " Algorthms on Strings Trees and Sequneces ", CambridgeUniversity Press, 1997.
7. P. Baldi,SBrunak, Bioinformatics; " A Machine Learning Approach ", MIT Press,1998.

BTHM705 ENGINEERING ECONOMICS & FINANCIAL MATHEMATICS

Credit	Lecture	Tutorial	Practical	CA1	MSE	ESE	Total
3	3	-	-	20	20	60	100

Course Objective:

- After completing this course, students will be able to conduct simple economic studies. They will also be able to make evaluation of engineering projects and make decisions related toinvestment

UNIT I: Introduction Engineering Economy

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering − Economics − Engineering efficiency, Economic efficiency, Scope of engineering economics − Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, P − V ratio, Elementary economic Analysis− Material selection for product, Design selection for a product, Process planning.

UNIT II: Value Engineering

Make or buy decision, Value engineering − Function, aims, Value engineering procedure. Interest formulae and their applications− Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor – equal payment series capital recovery factor − Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT III: Cash Flow

Methods of comparison of alternatives − Present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram), rate of return method, Examples in all the methods.

UNIT IV: Replacement And Maintenance Analysis

Replacement and Maintenance analysis − Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with anew asset − capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

UNIT V: Depreciation

Depreciation − Introduction, Straight line method of depreciation, − Declining balance method of depreciation − Sum of the years digits method of depreciation, − Sinking fund method of depreciation/Annuity method of depreciation, service output method of depreciation − Evaluation of public alternatives − Introduction − Examples – Inflation adjusted decisions − Procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

TEXT BOOKS/REFERENCES:

1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi,2001.
2. Suma Damodaran, “ Managerial economics”, Oxford university press2006
3. A Text book of Economic Theory: by stonier and hauge,pearsonPublication.
4. Modern Economic Theory: by Sampat Mukherjee, New Age InternationalPublisher
5. Engineering Economics: by Degramo ,prenticeHall.
6. International Economics: by Bo Sodersten,Macmillan.
7. Principle of Macroeconomics : by Rangarajan and Dholokia, Tata McGrawHill.
8. Monetary Economics: by Suraj B.Gupta, Schand.
9. Project planning analysis, Selection, Implementation and review: by Prasanna Chandra, Tata McGraw Hill Education.8.Cost Accounting: by Jawahar Lal ,McGraw Hill.

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM NPTEL

Sr. No	SEMESTER	COURSE CODE	NAME OF SUBJECT AS PER CURRICULUM	SWAYAM / NPTEL COURSE	NAME OF INST. OFFERING COURSE	RELEVANCE	DURATION OF COURSE (IN WEEK)
1	III	BTBS301	Engineering Mathematics – III	Transform Calculus and its Applications in Differential Equations	IIT KHARAGPUR	50%	12
2	III	BTBMC303	Analog and Digital Circuits	Analog Electronic Circuits	IIT KHARAGPUR	50%	12
				Digital Electronic Circuits	IIT KHARAGPUR	50%	12
3	IV	BTBMC402	Biomedical Signal Processing	Biomedical Signal Processing	IIT KHARAGPUR	55%	12
4	IV	BTHM403	Basic Human Rights	Basic Human Rights	IIT GUWAHATI	40%	12
5	IV	BTBMPE404A	Biomechanics	Mechanics of Human Movement	IIT MADRAS	30%	12
				Neuroscience of Human Movements	IIT MADRAS	30%	12
6	IV	BTBMPE404B	Network Analysis	Basic Electrical Circuits	IIT MADRAS	70%	12
7	IV	BTBMPE404C	Principles of communication system	Principles of Communication Systems - I	IIT KANPUR	45%	12
8	IV	BTBMOE405B	Quality Control and Regulatory Aspects in Medical Devices	Regulatory Requirements for Medical Devices and IVD Kits in India	DR. MALAY MITRA, NPTEL	60%	4
9	V	BTBMC502	Microprocessor and Microcontroller BasedBiomedical instrumentation	Microprocessors And Microcontrollers	IIT KHARAGPUR	70%	12
10	V	BTBMPE503A	Artificial Intelligence & neural network	Artificial Intellegence: Search Methods for Problem Solving	IIT MADRAS	50%	12
11	V	BTBMPE503C	Embedded &Real Time System	Embedded Systems	IIT DELHI	30/15	12
12	V	BTBMOE504A	Applied Optoelectronics in medicine	Laser: Fundamentals and Applications	IIT KANPUR	50%	8
13	V	BTBMOE504B	Biomedical MEMS	MEMS & Microsystems	IIT KHARAGPUR	80%	8

14	VI	BTBMC601	Biomedical control system	Control engineering	IIT MADRAS	65%	12
15		BTBMC602	Microelectronics and integrated Circuits	Microelectronics: Devices to Circuits	IIT ROORKEE	60%	8
16		BTBMPE603B	Applied Neural Networks & Fuzzy Logic in Medicine	Fuzzy Logic and Neural Networks	IIT KHARAGPUR	65%	8
17		BTBMPE603C	Robotics & automation	Robotics	IIT KHARAGPUR	40%	8
18		BTBMOE604A	Brain computer interface development engineering	Human-Computer Interaction	IIT GUWAHATI	65%	8
19		BTHM605	Employability & Skill Development	Technical English for Engineers	IIT MADRAS	35%	8
				Soft skills	IIT ROORKEE	20%	12
20	VII	BTBMOE701A	Computational Fluid Dynamics analysis in medicine	Computational Fluid Dynamics	IIT KHARAGPUR	75%	12
21		BTBMOE701B	Physiological system & modeling	Modelling and Simulaton of Dynamic Systems	IIT KHARAGPUR	40%	8
22		BTBMOE701C	Nanotechnology	Biomedical nanotechnology	IIT ROORKEE	20%	4
23		BTBMPE702B	Tissue Engineering	Tissue engineering	IIT MADRAS	85%	8
24		BTBMPE703A	Biomaterial	Medical Biomaterials	IIT MADRAS	20%	8
25		BTBMPE703B	Bioelectricity	Bioelectricity	IIT KANPUR	70%	12
26		BTBMPE704B	Bioinformatics	Bioinformatics: Algorithms and Applications	IIT MADRAS	70%	12

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM COURSERA

Sr. No	SEMESTER	COURSE CODE	NAME OF SUBJECT AS PER CURRICULUM	COURSERA COURSE	NAME OF INST. OFFERING COURSE	RELEVANCE	DURATION OF COURSE (IN WEEK)
1	III	BTHM403	Basic Human Rights	Human Rights for Open Societies	Utrecht University	60%	4
2		BTBMPE404B	Network Analysis	Linear Circuits 1	The Georgia Institute of Technology	65%	4
3	V	BTBMPE503A	Artificial Intelligence & Neural network	Neural Networks and Deep Learning	Andrew NG Stanford University	50%	6

4		BTBMOE504B	Biomedical MEMS	Biomedical MEMS	University of West England- Juergen Brugger	10%	6
5	VI	BTBMPE603B	Applied Neural Networks & Fuzzy Logic in medicine	Neural Networks and Deep Learning	Andrew NG Stanford University	50%	6
6	VII	BTBMOE701C	Nanotechnology	Nanotechnology	Israel Institute of Technology -Prof. Hossam Haick	10%	4
7		BTBMPE704B	Bioinformatics	Bioinformatics	Pavel Pevzner University of California San Diego	40%	4

COURSE CURRICULUM MAPPING WITH MOOC PLATFORM Edx

Sr. No	SEMESTER	COURSE CODE	NAME OF SUBJECT AS PER CURRICULUM	EDx Course	NAME OF INST. OFFERING COURSE	RELEVANCE	DURATION OF COURSE (IN WEEK)
1	III	BTBS301	Engineering Mathematics – III	Differntial Equations	Haynes Miller(MIT),David Jerison(mIT)	35%	4
2		BTBMC302	Human Anatomy & Physiology	Human Anatomy	John Yuen,Benson Lau , The Honk kong Polytechnical University	50%	6
3		BTBMC303	Analog and Digital Circuits	Fundamentals of Transistors	Marke S lundustrom (Purude university)	30%	4
4	IV	BTBMC402	Biomedical Signal Processing	Discrete time signals & systems	Richard G. Baraniuk (Rice University)	50%	6
5		BTBMPE404A	Biomechanics	Principles of Biochemistry	Alain Viel(Harvard University)	20%	4
6		BTBMC602	Microelectronics and integrated circuits	Photonic Integrated Circuits	Stefan Preble (Rochester Institute of Technology)	30%	4
				Silicon Photonics Design fabrication and data Analogy	Lukas Chrostowski (University of British Columbia)	30%	4
7	VI	BTBMPE603B	Applied Neural Networks& Fuzzy Logic in medicine	Artificial Intlligence	ColumbiaX	30%	4
8	VII	BTBMPE603C	Robotics & automation	Robotics Locomotion Engineering	Dan Koditschek (Yale University)	25%	4
9		BTBMOE701B	Physiological system & modeling	Introduction to Stewarts Model of Physionlogical	David Rubin(Wits University)	10%	4
10		BTBMPE704B	Bioinformatics	Statistical Analysis in Bioinformatics	James Coker University of Maryland	60%	6