University of Mumbai

No. AAMS_UGS/ICC/2022-23/ 128

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No.UG/138 of 2016-17 dated 9th November, 2016 relating to the revised syllabus of Master of Engineering (Bio-Medical Engineering) (Sem.– I to IV) (CBCS).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Biomedical Engineering at its meeting held on 13th May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.40 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.40 (R) and that in accordance therewith, the revised syllabus of M.E. (Biomedical Engineering) (Sem.– I to IV) (CBCS) (REV-2022 Scheme) has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

(Dr. Shailendra Deolankar)
I/c Registrar

MUMBAI – 400 032
20th October, 2022

To

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

A.C/6.40(R)/11/07/2022

****

No. AAMS_UGS/ICC/ 2022-23/ 128

20th October, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Biomedical Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Desktop/Circular of Engineering/Priya

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC – 11 July 2022ItemNo.– 6.40(R)

UniversityofMumbai

RevisedSyllabusfor

M.E. (BiomedicalEngineering)

Semester–

(ItoIV)(ChoiceBasedCreditSyste

m)

(Witheffectfromtheacademicyear2022-23)

University of Mumbai

O: _____ **Title of Course**	M.E. (Biomedical Engineering)
O: _____ **Eligibility**	After completing Graduation in Engineering as per the Ordinance O.6243
R: _____ **Passing Marks**	45%
No. of years/Semesters:	2 years, 4 Semesters
Level:	P.G. / ~~U.G./ Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised
To be implemented from Academic Year :	With effect from Academic Year : 2022-23

Dr. Manali Godse
Chairman
of Ad-hoc Board of Studies in Biomedical Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology

Program Structure for First Year Masters of EngineeringSemesterI &II

UNIVERSITYOFMUMBAI

(WithEffectfrom2022-2023)

Semester I

Course Code	CourseName	Teaching Scheme (ContactHours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
BMC101	BiomedicalSignal Analysis	3	--	--	3	--	--	3
BMC102	Biomedical Instrumentation	3		--	3		--	3
BMPE101	ProgramElective 1	3	--	--	3	--	--	3
BMPE102	ProgramElective 2	3	--	--	3	--	--	3
BMIE101	InstituteElective1	3	--	--	3	--	--	3
BML101	ProgramLab-I	--	2	--	--	1	--	1
BMSBL101	Skill BasedLab-I	--	4$	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract /Oral	Total
		InternalAssessment			End Sem.Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
BMC101	BiomedicalSignal Analysis	20	20	20	80	3	--	--	100
BMC102	Biomedical Instrumentation	20	20	20	80	3	--	--	100
BMPE101	ProgramElective 1	20	20	20	80	3	--	--	100
BMPE102	ProgramElective 2	20	20	20	80	3	--	--	100
BMIE101	InstituteElective1	20	20	20	80	3	--	--	100
BML101	ProgramLab-I	--	--	--	--	--	25	25	50
BMSBL101	Skill BasedLab-I	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	--	**75**	**75**	**650**

SemesterII

Course Code	CourseName	TeachingScheme(ContactHours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC201	HealthcareDatabaseManagement System	3	--	--	3	--	--	3
BMC202	MedicalImaging& ImageProcessing	3		--	3		--	3
BMPE201	ProgramElective 3	3	--	--	3	--	--	3
BMPE202	ProgramElective 4	3	--	--	3	--	--	3
BMIE201	InstituteElective2	3	--	--	3	--	--	3
BML201	ProgramLab-II	--	2	--	--	1	--	1
BMSBL201	SkillBasedLab-II	--	4$	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract /Oral	Total
		InternalAssessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
BMC201	HealthcareDatabase Management System	20	20	20	80	3	--	--	100
BMC202	MedicalImaging& ImageProcessing	20	20	20	80	3	--	--	100
BMPE201	ProgramElective 3	20	20	20	80	3	--	--	100
BMPE202	ProgramElective 4	20	20	20	80	3	--	--	100
BMIE201	InstituteElective2	20	20	20	80	3	--	--	100
BML201	ProgramLab-II	--	--	--	--	--	25	25	50
BMSBL201	SkillBasedLab-II	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	--	**75**	**75**	**650**

Note 1: Skill Based Lab- I and II are focused on the learning through experience. SBL shall facilitate the learner toacquire the fundamentals of practical engineering in his or her specialization in a project-oriented environment. Thelearningthroughskillbasedlabscanbeusefulinfacilitatingtheirresearchworkandhenceusefulinearlycompletionoftheir dissertation work.

SemesterIII

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMMP301	MajorProject: Dissertation-I	--	20	--	--	10	--	10
Total		**00**	**20**	**00**	**00**	**10**	**--**	**10**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
BMMP301	MajorProject: Dissertation-I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	--	**100**	**--**	**100**

OnlineCreditCourses

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMOCC301	OnlineCreditCourse-I	--	--	--	--	--	--	3
BMOCC302	OnlineCreditCourse-II	--	--	--	--	--	--	3
Total		**--**	**--**	**--**	**00**	**00**	**00**	**06**

Note2: It ismandatory tocompletethe Online CreditCourses (OCC)available onNPTEL / Swayam /MOOC orsimilarplatformapprovedbyUoM.Thesetwocoursesshallbecompletedinanysemesterlorlllorlll,butnotlaterend of the Semester III. University shall make a provision that credits earned with OCC- I and OCC-II shall beaccounted in the third semester grade-sheetwith actual names of courses. The learner shall be allowed to take up thesecourses from his or her institute or organisation/ industry where his / her major project is carried out. The students shallcomplete the courses and shall qualify the exam conducted by the respective authorities/ instructor from the platform.Thefeesforanysuch courses andthecorrespondingexaminationshallbe borne bythelearner.

OnlineCreditCourse –I

The learner shall opt for the course in the domain of Research Methodology **or** Research & Publication Ethics or IPR.Theopted course shallbe of 3 creditsof equivalentnumberof weeks.

OnlineCreditCourse–II

The learner shall opt for the course recommended by Faculty Advisor/ Project Supervisor from the institute. The optedcourseshallbe of 3creditsofequivalentnumberofweeks.

Semester IV

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMMP401	Major Project :Dissertation-II	--	32	--	--	16	--	16
Total		**--**	**32**	**--**	**--**	**16**	**--**	**16**

Course Code	CourseName	ExaminationScheme							
		Theory					Term Work	Pract/ Oral	Total
		InternalAssessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test-1	Test-2	Avg					
BMMP401	MajorProject: Dissertation-II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	--	**100**	**100**	**200**

Total Credits:

68Note3: TheDissertation-II submissionshallnotbepermittedtillthelearnercompletesalltherequirementsMEcourse.

Note 4: The contact hours for the calculation of load of the teacher for Major Project are as follows:MajorProjectDissertation Iand II-02Hour /week/student

GuidelinesforassessmentofDissertation-I

StudentsshoulddoliteraturesurveyandidentifytheproblemforDissertationandfinalizeinconsultationwithGuide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solutionto the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification andcompilethe reportin standardformat. GuidelinesforAssessmentofDissertation-I.

Dissertation-Ishouldbe assessedbased onfollowingpoints

- Qualityofliteraturesurveyand noveltyintheproblem
- Clarityofproblemdefinitionandfeasibilityofproblemsolution
- Relevancetothespecialization
- Clarity ofobjectiveand scopeDissertation-Ishould beassessedthroughapresentationby apanelofinternalexaminersandexternal examiner appointedbytheHead ofthe Department/InstituteofrespectiveProgramme.

GuidelinesforassessmentofDissertationII

DissertationIIshouldbeassessedbasedonfollowingpoints:

- Qualityofliteraturesurveyandnoveltyintheproblem
- Clarityofproblemdefinitionandfeasibilityofproblemsolution
- Relevancetothespecializationorcurrentresearch/industrial trends
- Clarityofobjectiveandscope
- Qualityofworkattemptedorlearnercontribution
- Validationofresults
- Qualityofwrittenandoralpresentation

Studentsshouldpublishatleastonepaperbasedontheworkinreferred National/Internationalconference/Journalofrepute.

DissertationIIshouldbeassessed byinternalandExternalExaminers appointedbytheUniversityofMumbai.

ProgramElectiveCourses

Subject Code	**Department LevelOptionalCourse-I**	**Subject Code**	**Department LevelOptionalCourse-II**
BMPE1011	EmbeddedSystemsin BME	BMPE2011	Bio-rheology
BMPE1012	BiomaterialsandImplants	BMPE2012	RoboticsinBiomedical Engineering
BMPE1013	Telemedicine	BMPE2013	NeuralNetworks ApplicationsinMedicine
BMPE1021	Basicsof Human Anatomy&Physiology	BMPE2021	ComputerNetworkingin Medicine
BMPE1022	BiomedicalInformatics	BMPE2022	Lasersand FiberOptics inMedicine
BMPE1023	HospitalManagementand InformationSystem	BMPE2023	InternetofThingsin Medicine

SubjectCode	SubjectName	Credits
BMC101	**BiomedicalSignalAnalysis**	**03**

CourseObjectives:

- Tobuild astrongbaseinunderstandingbiomedical signals
- Todevelop competencyinanalyzingthe processingthe biomedical signals
- Totrainandmotivateforhighereducationandresearchinordertomakecontributiontostateoftheart health carefor all

CourseOutcomes: Learnerwillbeableto

- Understandthefundamentalsofbiomedicalsignals andtheiranalysisforextractingthediagnosticinformation
- Understandthetime-domainandfrequency-domainfilteringforremovalofartifacts
- UnderstandandimplementthetechniquesfordetectionofeventsandCorrelationanalysisofEEGrhyt hms
- Understandthe frequencydomaincharacterization:Modelingthebiomedicalsystems.

Module	Contents	Hours
1	**Introductiontobiomedicalsignals:**Natureofbiomedicalsignals;Actionpotentials;Ele ctroneurogram;Electrocardiogram;Electrogastrogram;Phonocardiogram; Carotid pulse; Signal from catheter-tip sensors; Speech signal;Vibromyogram;Vibroarthogram;Bio-acousticsignals;Objectiveofbiomedical signalanalysis;Difficultiesinbiomedicalsignalanalysis.	5
2	**Concurrent, coupled and correlated processes:** ECG and PCG; PCG and carotidpulse;ECGandatrialelectro-gram;Cardiorespiratoryinteraction;Heartratevariabilityanditsimportance;EMGandV MG;Kneejointandmusclevibration signals;SegmentationofPCG;Diagnosisandsleepapnea.	5
3	**Fundamental concept of filtering:** Linear shift-invariant filters; Transform domainanalysis of signals and systems; Pole-zero plot; Discrete Fourier transform and itsproperties.Random, structuredand physiologicalnoise; Casestudies. **FilterDesigns:**Synchronizedaveraging,MAfilters,Derivative-basedoperatorsto remove low-frequency noise; Specifications of filters; Butterworth low pass andhighpassfilters;Wienerfilter;Adaptive filters.	8
4	**Detection of events:** Problems with case studies; Detection of events and waves;Derivative-basedmethodforQRSdetection;Pan-TompknsalgorithmforQRSdetection;Detectionofdichroticnotch;DetectionofEEGrhyt hmsrelatedto seizure;CoherenceanalysisofEEGchannels;Homomorphicfiltering.	8
5	**Analysisofwaveshapeandwaveformcomplexity:**QRScomplexincaseofbundle-branchblock;EffectofmyocardialischemiaandinfractiononQRSwaveshape;Ectopicbe ats;complexityofEMGinterferencepattern;PGintensitypattern;AnalysisofERO;Morp hologic analysis of ECG;Correlation coefficient;Minimum phase correspondent and signal length; ECG waveform analysis;**Envelope extraction and analysis:** Amplitude modulation; Synchronized averagingof PCG envelopes;	8
6	**Frequency domain characterization:** Myocardial elasticity; Heart sound spectra;Frequency analysis of murmurs to diagnose valvular defects; Estimation of PSD;MeasuresfromPSD;Spectralanalysis of EEG.	5

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total 04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

TextBooks:

1. Biomedicalsignalanalysis,SecondEdition,RangarajM.Rangayyan,IEEEPress445HoesLanePiscataway, NJ

ReferenceBooks:

1. BiomedicalTransducersandInstruments byTatsuoTogawa, ToshiyoTamura,P.Ake Oberg
2. Medical Instrumentation Applications and Design, John G. Webster, 3rd edition John Wiley and Sons.Inc. 1999

UsefulLinks:

1 Biomedical Signal Processinghttps://nptel.ac.in/courses/108105101

SubjectCode	SubjectName	Credits
BMC102	**BiomedicalInstrumentation**	**03**

CourseObjectives:

- Tomakestudentstounderstandvarioustypesofmedicalinstruments,theirworkingprinciples,and applications.
- Toteach thestudents design conceptsof someofthemonitoringequipments.
- Tomakestudentstoknowaboutlifesavingandsurgicalequipmentsusedinemergency,ICU,ICCUuni ts.
- Tostudyclinical laboratoryinstruments.
- Tounderstandpulmonaryfunctionandassessment.
- Tolearnsafetyaspectsoftheinstruments frompatient'sviewpoint.

Courseoutcome:

- Studentscandesign electro-diagnosticinstruments.
- Learnerhasunderstooduseofmedicalequipmentinvariousdepartmentsinthehospital.
- Learnercandesigninstrumentsusedfordiagnostic,therapeutic,diagnosis,monitoringpurposes.
- Alearner willbe abletoapplyhisknowledgeinlaboratoryinstruments.
- Analyzepulmonaryfunction.
- Implementsafetystandardsin biomedicalequipments.

Module	Detailedcontent	Hours
1	**Biophysicalsignals:**Actionpotentials;BiophysicalsignalssuchasECG,EMG,EEG; Electrodesandacquisitionsystems;clinicalaspects;variabilityanalysis;impedanceplethysm ography&cardiography;photo plethysmography&applications.	09
2	**Patientmonitoring:**ECG,bloodpressure,temperature,respiration,oxygensaturationandca rdiac outputmonitoring.	06
3	**Life-savingequipment:**Cardiacpacemaker;Defibrillator;Hemodialysis;anaesthesiamachines.	06
4	**Clinical laboratory instruments:** Spectrophotometry; Flame photometry;Automatedbiochemicalanalysissystem;Electrophoresis;ELISA; Chromatography;pH meters; BloodO2andPCO2measurement	06
5	**Pulmonary function analysis:** Respiratory parameters; Spirometry;Pneumotachometers;Measurementof volumes;Ventilator.	06
6	**Patientsafety:**Electric shock hazards;Leakage currents; Safety codes for biomedicalequipments; Electricalsafetyanalyzer;Testingofbiomedicalequipment.	06

Assessment

Internal:

Assessmentconsistsoftwotestsoutofwhich;oneshouldbeacompulsoryclasstest(onaminimumof02modules)and theotheriseitheraclass test orassignment onliveproblems or course projects.

End Semester Examination: Question paper comprises of 4 questions each carrying 20 marks. Question no. 1comprises ten small multiple choice questions (2 marks each). Question nos. 2-4 comprise either 6 shortquestions(5 marks each)or3 longquestions(10 markseach);studentcansolve any4 or2 respectively.

TextBooks:

1. MedicalInstrumentation:Application&Design,JGWebster
2. IntroductiontoBiomedicalEquipmentTechnology,Carr&Brown,PearsonEducation
3. Handbook of Biomedical Instrumentation, RS Khandpur, 3rd Edition, McGraw Hill Education (India) Pvt.Ltd.

ReferenceBooks:

1. BiomedicalEngineeringDesignHandbook,2nded,volI&II,Myer Kutz,McGrawHill
2. PrinciplesofAppliedBiomedicalInstrumentation,Geddes&Baker,JohnWiley

SubjectCode	SubjectName	Credits
BMPE1011	**EmbeddedSystemsinBiomedicalEngineering**	**03**

CourseObjective:

- ToprovidefundamentalknowledgeofEmbeddedSystem
- Toteacharchitectureand communicationprotocolsusedforES
- Toprovideknowledgeof various versionsofARM processors anditshardware.
- ToteachprogrammingofARMprocessorusingASMandembedded‘C’
- ToteachapplicationdevelopmentwithARMprocessor.
- Toteachdigitalinstrumentation.

CourseOutcome:Thelearnerwill

- knowarchitectureofARMprocessor.
- beacquaintedwithdifferentversionsofARMprocessors
- beabletoprogramARMprocessorsinASMand embedded‘C’.
- useARMprocessorsforvariousapplicationsofembeddedsystem.
- applydigitalinstrumentationforpractical applications.

Module	Detailedcontent	Hours
1	**Introductiontoembedded system** Introductiontoembeddedsystem;Embeddedsystemarchitecture;Characteristics & classification of embedded systems; Challenges and designissuesinembeddedsystems;Fundamentalsofembeddedprocessors;CISCvs. RISC; FundamentalsofVon Neumann&Harvardarchitectures.	04
2	**Embeddedhardware** Introduction to embedded architecture; Embedded cores; Types of Memories;sensorinterface. **Communicationinterfaces** Comparative study of serial communication interfaces (RS-232, RS-485), SPI,12C, CAN, USB, Wired LAN (Ethernet) (IEEE 802.3), Wireless LANs &Long-DistanceComm.;WirelessFidelity-LoRAMesh;Selectioncriteriaof aboveinterfaces.	06
3	**ARMarchitecture** ARMfamilycorearchitecture;Versionsandvariants;Programmer’smodel; Programstatusregisters;Barrelshifter;Datatypes;Nomenclature;Processormodes;Pipeliningconcept.	08
4	**ARMprocessor programming** Addressingmodes;ARMInstructionset;Thumbprogrammer’smodel& thumbinstructionset;SimpleASM/Cprograms.	08
5	**Interfacingexamples** ARMprocessorinterfacingwithkeypad,LCD,steppermotoretc.;Completeapplicationlikeensemble averaging	08
6	**Digitalinstrumentation** Summation-deltaADC’s;Digitalinstrumentationexamples,ADS1298forECG,AFE4300forBCA(bodycompositionanalysis)&AFE4490for oxygensaturation.	05

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02

Modules)andtheotheriseither aclasstest orassignment onliveproblemsorcourseproject.

TheoryExamination:

1. Questionpaperwill compriseoftotal06questions, eachcarrying20marks.
2. Total04 questions needto be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswill be asked.
4. Remainingquestionswillberandomlyselected from allthemodules.

BooksRecommended:

Textbooks:

1. Embeddedsystems–Architecture,programmingandDesign,byRajkamal,TataMcGrawHill
2. EmbeddedReal-TimeSystemsprogrammingbySriramIyer,PankajGupta,TataMcGrawHill

ReferenceBooks:

1. AnEmbeddedSoftwarePrimer byDavidESimon,PearsonEducation
2. ARMArchitectureReferenceManual
3. WilliamHohl:'ARMAssemblyLanguage'FundamentalsandTechniques
4. SteveFurber:'ARMsystemonchiparchitecture',AddisionWesley

LinksforNPTELLectures:

1. https://nptel.ac.in/courses/108/102/108102045/
2. https://nptel.ac.in/courses/106/105/106105193/

SubjectCode	SubjectName	Credits
BMPE1012	**BiomaterialsandImplants**	**03**

CourseObjectives:

- To understandwhat biomaterials are,whatare they made of, types of materials usedfor making bio-implants and in which all conditions of the body they are used. Also itemphasizes on various techniques to understand how the properties of these materialsarestudied.

CourseOutcomes:

- A leaner can design an implant as per the need and alsowill know itscompatibility,what all complications it can lead to. Also understand how a biomaterial improves thequalityof life and enhances the aesthetic looks ofan individualtoo.

Module	Detailedcontent	Hours
1	**Introduction:** Introduction of biomaterials; Classification of biomaterials; Thermal,mechanical andbiologicaltestingof biomaterials.	06
2	**Physiologicaldefensemechanismsofthebodyagainstbiomaterials:**Inflammationand woundhealing;Bloodclottingsystem;Immunesystem;Complement system.	05
3	**Propertiesandapplicationsofbiomaterials:**Tantalum,Platinumandothernoblemetals. **Biopolymers:**Collagen,Elastin,Mucopolysaccharides,Proteoglycans,Celluloseandotherderivatives,Chitinand other polysaccharides.	08
4	**Cardiovascular implants and extracorporeal devices:** Vascular implants; Cardiacpacemakers; Bloodsubstitutes; Extracorporealbloodcirculationdevices	04
5	**Biomaterials in opthalmology:** Contact lenses; Optical implants; Drainage tubes inglaucoma; Vitreousimplants;Acrylateadhesives;Artificialtears. **Dental materials:** Tooth composition and mechanical properties; Impressionmaterials, bases, liners and varnishes for cavities; Fillings and restorative materialsforcavities;Oralimplants;Collagenindentistry.	08
6	**Techniques for characterization of surface properties of biomaterials:** Electronspectroscopyforchemicalanalysis(ESCA);Secondaryionmassspectrometry(SIMS);Surfaceinfraredtechniques;Transmissionelectronmicroscope(TEM);Scanningelectronmicroscope(SEM);Scanningtunnelingmicroscope(STM);Atomic force microscope(AFM), Surface enhanced Raman spectroscopy (SERS);Highresolution electron energylossspectroscopy(HREELS).	08

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwill compriseoftotal06questions, eachcarrying20marks.
2. Total04 questions needto be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswill be asked.
4. Remainingquestionswillberandomlyselected from allthemodules.

TextBooks:

1. AnIntroductiontoMaterialsinMedicinebyBuddyD.Ratner,AllanS.Hoffman,Frederick J.Schoen,JackE.Lemons
2. Biomaterails bySujataV.Bhat
3. Polymers:BiomaterialsandMedicalApplications,EncyclopediaReprintSeries,Editor:Jacqueline I. Kroschwitz.

ReferenceBooks:

1. BiomaterialsanIntroductionbyJ.B.Park

SubjectCode	SubjectName	Credits
BMPE1013	**Telemedicine**	**03**

CourseObjectives:

- It emphasizes on various types of signals that are transmitted from one region toanother by various communications and networking techniques, how data is exchangedandthe safetyand securityof data is achieved.

CourseOutcomes:

- TelemedicineplaysawideroleinBiomedicalengineeringandtheleanercanunderstandhowt histechniquecanbeutilizedinphysiologicaldatatransfer,particularlyCardiacsignals in ambulatoryconditions.

Module	Detailedcontent	Hours
1	**Introduction:**Historyoftelemedicine;Blockdiagramoftelemedicinesystem;Definition ofbenefitsand limitations oftelemedicine.	04
2	**Typeofinformation**:Audio,video,stillimages,textanddata,fax,medicalinformationstor ageandmanagement;Patientinformationmedicalhistory,testreports,medicalimagesdiag nosisandtreatment;Informationondoctors,paramedics,facilitiesavailableandpharmace uticalinformation. **Type of communications and network**, PSTN, POTS, ANT, ISDN; Internet, air/wirelesscommunications,GSMsatellite,andmicrowave;Differentmodulationtechni ques;.Realtime telemedicine.	08
3	**Dataexchange:**Networkconfiguration;Circuitandpacketswitching;H.320series (videophonebasedISBN);T.120,H.324(videophonebasedPSTN);Videoconferencing.	06
4	**Data security and standards:** Encryption, cryptography, mechanisms of encryption,phasesofencryption;Protocols:TCP/IP,ISO-OSI;StandardstobefollowedDICOM, HL7.	06
5	**Ethicalandlegalaspectsoftelemedicine:**Confidentialityandthelaw;patient rightsandconsent;Accesstomedicalrecords;Consenttreatment,jurisdictionalissues; Intellectualproperty rights.	07
6	**Applicationsoftelemedicine**	08

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheoth eriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwill compriseoftotal06questions, eachcarrying20marks.
2. Total04 questions needto be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswill be asked.
4. Remainingquestionswillberandomlyselected from allthemodules.

TextBooks:

1. Olga(EDT)Ferrer–Roca, M.Sosa(EDT) IudicissaHandbookofTelemedicine IOSpress

ReferenceBooks:

1. A.C.Norris,EssentialsofTelemedicineandTelecareJohnSons&Ltd,2002Referencehttp://jntu.ac.in/dap/syl.html

Subject	SubjectName	Credit
BMPE1021	**BasicsofHumanAnatomy& Physiology**	**03**

CourseObjectives:

- Tounderstand the humananatomyand functions ofvarious bodystructures.
- Tounderstanddifferentphysiologicalprocessestakingplaceinsidehuman body.

CourseOutcomes:

- Studentwill bewell versed withtheanatomyandphysiologyofhuman body.
- He/shewillbeabletocorrelatetheknowledgeofmedicineandengineeringfordevelopmentof various instruments.

Module	DetailedContents	Hours
1.	**Introduction to human body:** Homeostasis;Blood composition, functionsofblood,functionsofRBC,WBCandplatelets;Physical&physiological properties ofblood	05
2.	**Transport mechanism in cell and generation of action potential:** Structure&functionsofcell;Cellulartransport(activeandpassive);Diffusion,osmoticpressure,bodyfluidcompartments;Originofcellmembrane potential,actionpotential.	06
3	**Cardiovascular system:** Anatomy of heart; Anatomy of vessels; Cardiacoutput;Heartsounds;Dynamicsofheart;Systemicandpulmonarycirculation;Bloodpressure&itsregulation;ECG**,**intra-cardiacECG, normalECG,methodforrecordingECG,leads; Cardiacarrhythmias.	09
4	**Respiratorysystem:**Anatomyoflungs,Partsofrespiratorysystem;Organizationofventilation;Diffusion,gasexchange;Measurementoflung volumes&capacities.	05
5	**Musculoskeletal system and central nervous system:** Anatomy of brain,spinal cord,organization & functions receptors, synapses, reflexes; ANS,PNS,ascending&descendingtracts;Skeletonanatomy,structure&functions ofnerve&muscle,mechanismofmusclecontraction;Neuro-musculartransmissionandprocessingofinformation.	07
6	**Endocrinesystem:**Secretionandfunctionofpituitarygland,hypothalamus, thyroidgland,parathyroidglands,adrenalglands,pinealgland&thymusgland; Hormonaldisorders.	07

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

Text Books

1. AnatomyandPhysiologyinHealthand Illness: RossandWilson.(ELBSPub)
2. TextbookofBiomedicalPhysiology –A.C. Guyton

ReferenceBooks

1. AppliedPhysiology -C.A.KeeleandEricNeil Samson,Wrights
2. ThePhysiologicalBasisofMedicinePractice-.Herbert Best CharlesandNormanTailo

SubjectCode	SubjectName	Credits
BMPE1022	**BiomedicalInformatics**	**03**

CourseObjectives:

- To understand various concepts like medical records, data acquisition and computing.It also helps in understanding how patient care monitors are helpful in acquiring dataandunderstandingthe importance and thegeneration ofcertain algorithms

CourseOutcomes:

- This helps in the Analysis and interpretation of various biological data with the help ofmedical records, mathematical analysis and computing. it is widely used in Tele healthsectortoo.

Module	Detailedcontent	Hours
1	**Introduction:** Origins of biomedical informatics; Relationship of biomedical informaticstootherfields.IntroductiontoBiomedicalInformaticsResearchMethodology; Datadrivenmedicine.	06
2	**ComputerbasedMedicalRecords:**Biomedicaldataacquisition;Patientcaresystems and patient monitoring systems; Storage and use of computer based medicalrecords.Representationsandalgorithmsforcomputational molecularbiology.	06
3	**DataMining:**Introductiontodatamining;Basicaspectsofdatameasurement; Typesofvariables,Visualizationand data exploration.	06
4	**InformationRetrieval:**Basicprinciplesofinformationretrievalandsearch;Document classificationalgorithms;Document clusteringalgorithms.	06
5	**Fitting Models:** Basic principles of fitting models to data, Classification Algorithms;Regression algorithms; Computational methods for biomedical image analysis andinterpretation.	06
6	**Information Management:** Management of information in healthcare organizations,public health informatics,healthinformationinfrastructure,consumerhealthinformatics,telehealthand m-healthandfuture ofbiomedical informatics.	09

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheoth eriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questions needtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarks will beasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

TextBooks:

1. PublicHealthInformaticsandInformationSystemsbyD.A.Ross,A.R.Hinman,K.Saarlas,andW.H. Foege (Hardcover– Oct16, 2002)

ReferenceBooks:

1. Androwich, I.A., Bickford, C.J., Button, P.S., Hunter, K.M., Murphy, J., and Sensmeier, J. (2002)Clinical Information Systems: A Framework for Reaching the Vision. Washington, DC: ANAPublishing

SubjectCode	SubjectName	Credits
BMPE1023	**HospitalManagementandInformationSystem**	**03**

CourseObjectives:

- It deals with computerized management of patient data, importance of computers inclinicallaboratory,howcomputerscanhelpinassistingdoctorstotakemedicaldecisions,roleof computers inconducting/performingtherapy.

CourseOutcomes:

- WiththeApplicationofComputersinmanyfields,particularlyinthehospitals,various Medical decisions have become much faster and patient's life safety is alsomuch more improved. Also at any given point of time, all possible medical data is alsoavailablein hospital dueto computerization.

Module	Detailedcontent	Hours
1	**Introduction to database management systems:** Database system applications;Database system versus file system; View of data, data models, database language,databaseusersandadministrators;Transactionmanagement,databasesystemstructures,application architectures.	06
2	**Hospitalinformationsystem:**Introduction,functionalcapabilitiesofacomputerized HIS; Need for computerizationinhospitals;Securityofcomputerrecords; Cost effectiveness of information processing by computer; Sources of datafordecisionmaking;Modesofdecisionoutputtophysician;Regenstriefcomputerized medicalrecordsystem;ComputerDBMSinobstetrics-gynecology; Computerbased morbidityregisters.	06
3	**Computerizedpatientdatabasemanagement:**Introduction;History taking bycomputer, dialogue with the computer, methods of history taking by computers;Patientdatabasemanagementbycomputers;Computerizedmedicalrecordevolution.	06
4	**Computersinclinicallaboratory:**Introduction;Databaseapproachtolaboratorycomputerization; Automated clinical laboratories, automated methods inhematology, chromosome analysis by computer; Computerized electrocardiography(ECG);AssessmentofperformanceofECGcomputerprograms; Computerizedelectroencephalography; Computerized electromyography.	09
5	**Computerassistedmedicaldecisionmaking:**Introduction;GeneralmodelofCMD, algorithmic methods, statistical pattern classification, decision analysis, fuzzyset theory, production rule systems, cognitive models, internist, QMR, KES; A rulebaseddecisionaidforTIA;Computersinthecareofcriticallyillpatients;Automated computerassistedfluidandmetabolicbalance;Pulmonaryfunctionevaluation; Cardiovascularphysiologicevaluation.	06
6	**Computer assisted therapy:** Introduction; Digitalis therapy, evaluation of patientresponse,assessingdigitalistoxicity;Computersforcareofrenaldisorders;Computer based cancerchemotherapyprotocoladvisor - oncocin; Automateddrugdelivery;Electromyogeniccontrolledlimbs;Computeraidsforthehandicapped: mobility, blind and visually handicapped, computer aids for the deaf,computer speechgeneration andrecognition.	06

Assessment

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TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

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TextBooks:

1. DataBaseManagementSystems(3rd)RaghuRamakrishnan,JohanisGehrkMcGrawhill

ReferenceBooks:

1.ComputersinMedicine–Dr.R.D.LeleTataMcgrawHillMedicalInformaticsaPrimer-MohanBansalTMH publications

SubjectCode	LaboratoryName	Credits
BML101	**ProgramLaboratoryI**	**01**

Module	Practicalbasedon
1	DC-to-DCconverterdesign
2	Studyof LVDT
3	Designandimplementationofanalogfilters(LP,HP,BP)forbio-signalconditioning
4	Designandimplementationofmedicalthermometer
5	Designofcurrentsources
6	Studyofvariouscharacteristicsofsensors
7	Interfacingmsp430 launchpad / Arduino.
8	Designandimplementationofbio-potentialamplifier

Termwork: Termworkconsistsofperforming08practicalmentionedasabove.Finalcertificationandacceptanceof the termworkensuressatisfactoryperformance oflaboratorywork.

Assessment:

EndSemesterExamination: Practical/Oralexaminationtobeconductedbyinternalandexternalexaminers.

SubjectCode	LaboratoryName	Credits
BMSBL102	SkillBasedLaboratoryI	02

Module	Practicalbasedon
1	R-wavedetectioninECG
2	Timedomainheart ratevariability
3	Frequencydomainheartratevariability
4	Nonlinearvariability
5	GUIdesign
6	Readingfilesandvisualization
7	Featuresextraction
8	Interpolation

Term work: Term work consists of performing 08 practical mentioned as above. Final certification andacceptanceof the termworkensuressatisfactoryperformanceoflaboratorywork.

Assessment:

EndSemesterExamination: Practical/Oralexaminationistobeconductedbyinternalandexternalexaminers.

SubjectCode	SubjectName	Credits
BMC201	HealthcareDatabaseManagementSystem	03

CourseObjective:

- To understand various features like hospital management, planning and design of variousdivisionsinahospital.Alsoemphasisisgiven on patientsafetyandcertainLegal aspects

CourseOutcome:

- The leaner will be able to understand the complete designing of the hospital, its safety forpatients, Also helps in understanding the supporting units in a hospital and hoe to deal variouslegalmatters in ahospital

Module	Detailedcontent	Hours
1	**Introductiontomanagement:**Basic managementprinciples;Processofmanagement;Roleof hospitaladministrator; **Computersinmedicine:**Computersinbiomedicalapplications;Roleofcomputersindatacollectionandanalysis;Computeraideddecisionmaking;Computerbasedmedical records;Dataanddatabasedadministration.	10
2	**Planninganddesigning:**Planninganddesignconsiderationsofvariousdept.likeOT,OPD,CSSD,Nursingunit,ICUs,pathology,radiology,pharmacyandothers; Developmentlifecycleandprototyping;Conceptualdesign.	09
3	**Hospitalsafetyandmanagement:**Securityandsafetyofhospitalproperty,staffandpatients; Importanceof disastermanagement;Medicalcodes.	04
4	**Patientsafety:**Electricalbeds,doubleinsulationsystem,patientisolation,grounding,rectificationof groundfaults.	04
5	**Hospitalservices:**Clinicalservices;Supportiveservices;Auxiliaryservicesandancillaryservices.	09
6	**LegalAspect:**Healthinsurance;Qualityassurance;Medicolegalaspects;Medicalethics.	04

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

TextBooks:

1. ElectricalsafetyinHealthcarefacility–H.H.Roth
2. HospitalPlanning,DesignandManagement-Kunders

ReferenceBooks:

1. Biomedical EthicsforEngineers-DomielAVallero
2. Computer inMedicine – R.D.Lele

SubjectCode	SubjectName	Credits
BMC202	**BiomedicalImaging&ImageProcessing**	**03**

CourseObjective:

- Identifytheroleof Imaginginclinicalpractice.
- Tostudytheoperatingprinciples,processesofimageacquisition,imagereconstruction,qualityControl aspects,advantages andLimitationsof variousimagingmodalities.
- TokeepthestudentsabreastwiththetechnologicaldevelopmentsinthefieldofMedicalImaging.
- To be able tostudy aboutapplying differentDigitalImage processing techniques on a givenimage.
- Todevelopcomputeraideddiagnosisinanalyzingandquantifyingbiomedicaldata.

CourseOutcome: Alearnerwillableto:

- Describeessentialphysics,principleandinstrumentationofX-rays andUltrasound.
- Apply their knowledge to understanding emerging Medical Imaging Tomographictechnologiesas CT, PET and SPECT.
- Describeessentialphysics,principle,pulsesequencesandinstrumentation ofMRI.
- Applyimageprocessingconceptsformedicalimagesandanalyzeimagesinthespatialdomain.
- AnalyzeimagesinthefrequencydomainthroughtheFouriertransform.
- Applytheconceptsofmorphologicaloperators,segmentation,featuresrecognitionandclassification.

Module	DetailedContents	Hours
1	**X-rayandultrasoundimaging:**Basicphysicsofx-rays;X-raym/ccontrols; Interaction of radiation with matter; X-ray imaging system; Flatpanel detectors; Digital radiography; Digital mammography; Fluoroscopy;Clinical applications; Basic physics of ultrasound; Interaction of ultrasoundwithbiologicalmatter;Ultrasoundtransducerandprobes;Displaymodes; Dopplerultrasound;Realtimescanner;Clinicalapplications.	7
2	**Tomographyimaging:**Tomographicreconstructiontechniques;CTgenerations; Detectors; CT system; CT contrast; Image quality; Artifacts;Clinicalapplications;WorkingprincipleandinstrumentationofSPECT& PET;hybridPET/CT;Clinicalapplications.	7
3	**MagneticResonanceImaging(MRI):**Relaxation parametersandtheirmeasurements; Magnets, RF coils and gradients in MRI; Slice selection,phase encoding, frequency encoding, pulse sequences: spin echo, inversionrecoveryandgradientrecalledecho;Clinicalapplications;Biologicaleffects andsafety.	7
4	**Imageenhancementinspatialdomain:**Fundamentalsofimageprocessing**;**Pointprocessingtechniques;Histogramprocessing;Neighborhoodprocessing;Logical(Boolean)operations;Convolution-basedoperations.	6
5	**Imageenhancementinfrequencydomain**:2D-DFT;Propertiesof2D-DFT;Sampling;Frequencydomainfilters;Homomorphicfilters;Cross-correlationandautocorrelation.	5
6	**Imagerestoration,featurerecognitionandclassification:**Morphological operators;Extensiontograyscaleimages;Introductiontosegmentation,	7

	thresholding, region-basedandboundary-based methods; Objectrecognition andclassification;Connectedcomponentslabeling;Featuresclassification;Structural/syntacticclassification.	

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

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TextBooks:

1. TheEssentialPhysicsofMedicalImaging,byJerroldTBushberg,J.AnthonySeibert,EdwinMLeidholdt,John M Boone, Lippincott.
2. PhysicsofMedicalImaging,TaylorandFrancisGroup.
3. Christensen'sPhysicsofDiagnosticRadiology,byThomasS.Curry,JamesE.Dowdey,RobertE.Murry.
4. ThePhysicsofDiagnostic Imaging,byDavidDowsett,PatrickAKenny, REugeneJohnston
5. DigitalImageProcessingforMedicalApplications,GEOFFDOUGHERTY,CambridgeUniversityPress.
6. DigitalImageProcessing,GonzalezandWoods-PearsonEducation

ReferenceBooks:

1. TheBiomedical EngineeringHandbook,Joseph D.Bronzino, CRCPress,SecondEdition.
2. Medical ImageProcessing,ReconstructionandRestoration,JiriJan**,**Taylor&Francis

UsefulLinks:

Course1:IntroductiontoBiomedicalImaging
https://www.edx.org/course/introduction-to-biomedical-imaging
Course2:FundamentalsofBiomedicalImaging:Ultrasounds,X-ray,positronemissiontomography(PET)andapplications
https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r
Course3:NPTELCourseonMedicalImageAnalysis,Dr.DebdootSheet,IndianInstituteofTechnology,KharagpurCourse Link*:https://nptel.ac.in/courses/108/105/108105091*
Course4:NPTELcourse onDigitalImageProcessing-NPTEL Lecture VideosbyProf.P.K.Biswasfrom IITKharagpur.*http://www.nptelvideos.com/course.php?id=541*

SubjectCode	SubjectName	Credits
BMPE2011	**Biorheology**	**03**

CourseObjective:

- Tounderstandvariouscharacteristicsoftissuesuchaselasticity,Viscosity,Plasticityandtypesofviscosityand Stress strain characteristics of tissue.
- Alsohow tissuescan bemodeledwill beunderstood.

CourseOutcome:

- Fromthetermselasticity,plasticityandviscosity,andusingStressStrainCurve,tissuemodelingcan beachieved.

Module	Detailedcontent	Hours
1	**Introduction:**Introduction to rheology and recap of basic equations of continuummechanics(kinematicsofdeformationandstressanalysis);Generaltheoryof constitutive equations.	10
2	**Tissue and cell elasticity:** Continuumapproach(lineartheory,nonlineartheory,strainenergyfunction,pre-stress;examples);Microstructuralapproach(microstructuralmodelsoflivingtissues);Statisticalapproach(thermodynamics ofelasticdeformation,rubberelasticity);Examples.	09
3	**Tissueandcellviscoelasticity:**Phenomenologicalapproach(stressrelaxation,creep,hysteresis,frequencyandtemperature effects);Examples.	06
4	**Linear viscoelasticity:**Continuumapproach;Lumpedmodels;Empiricalmodels(powerlaw,fractionalcalculus);Structuraldamping;Microstructuralandmolecularapproach;Polymerchaindynamics; Examples.	06
5	**Elements ofnonlinear viscoelasticity:**Examplesof empirical, semiempirical andmolecularapproachesin studiesoflivingtissues.	04
6	**Elementsoftissueplasticityandvisco-plasticity:**Permanentdeformation,hysteresis,yieldstress;Empiricalandlumpedmodelsofplasticandvisco-plastic behavioroflivingtissues.	04

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

TextBooks:

1. Fung,Y.C.Biomechanics–MechanicalPropertiesofLivingTissues,2nd edition,Springer:NewYork, 1993.
2. Fung,Y.C.Biomechanics–Motion,FlowandGrowth,Springer: NewYork,1990.
3. Fung,Y.C.Biodynamics–Circulation,Springer,1984.

4. Fung,Y.C.,N.Perrone,andM.Anliker(editors).Biomechanics–ItsFoundationsandObjectives,Prentice-Hall:Englewood Cliffs, NJ,1972.
5. Mow,V.C.,F.Guilak,R.Tran-Son-Tay,andR.Hochmuth(editors).CellMechanicsandCellularEngineering,Springer:NewYork, 1994.
6. Mofrad,M.R.K.,andR.D.Kamm(editors).CytoskeletalMechanics:ModelsandMeasurements.Cambridge UniversityPress:New York2006

ReferenceBooks:

1. M.R.King(editor).PrinciplesofCellularEngineering:UnderstandingtheBiomolecularInterface.ElsevierAcademicPress, 2006.
2. Abé,H.,K.Hayashi,andM.Sato(editors).DataBookonMechanicalPropertiesofLiving Cells,Tissues,and Organs, Springer:Tokyo, 1996.
3. Silver, H. F. Biological Materials: Structure, Mechanical Properties, and Modeling of Soft Tissues, NewYorkUniversityPress:NewYork, 1987.10. Ward, I.M. MechanicalProperties ofSolidPolymers,2ndedition,Wiley: Chicester,1983
4. Turner,A.,Jr. MechanicalBehaviorofHighPolymers,Interscience:NewYork,1984.
5. Erich,F.R.(editor). Rheology–Theoryand Applications,Vol.1-AcademicPress,1956

SubjectCode	SubjectName	Credits
BMPE2012	**RoboticsinBiomedicalEngineering**	**03**

CourseObjective:

- ToUnderstandControlof actuatorsinRoboticMechanisms, roboticsensorsandKinematicsofRoboticArms
- Tomakethelearnerawareof fundamental conceptsof Robotics
- Tomakelearner studydirect andInverseKinematics ofRobots
- Tomakelearner knowtheTrajectoryandMotionplanning.
- TomakethelearnerknowtheBiomedical applicationsofrobotics

CourseOutcome: Ithelpsthelearnerto

- designaRobotforvariousapplicationslikesurgery,therapyandclinicalapplications.
- describedirectandinversekinematicsofrobots.
- describeworkspaceenvelop
- plantrajectoryforrobots
- applyvarious imageprocessingtools forroboticmanipulation
- implementmotionplanningsolutionsusingvariousalgorithms
- illustratemedicalapplicationsofrobotsUnderstand packagingtechniquesusedinMEMS

Module	Contents	Hours
1.	**Fundamentals of robotics**: Automation and robots; Robot classification; Robotcomponents;Robotspecification;Joints,coordinates,coordinateframes,workspace,languagesandapplications. **Directkinematics:**Dotandcrossproducts,co-ordinateframes;Rotations;Homogeneouscoordinates;Linkco-ordinates,armequationandarmmatrixderivation(twoaxis,threeaxisandfouraxisscara); Configurationoffiveaxisand six axisrobots(armmatrixderivationandequationnotexpected).	07
2.	**Inverse kinematics:** General properties of solutions of inverse kinematics; Methodsfor finding solution; Tool configuration vector and inverse kinematics solution fortwo axis, three axis and four axis robots. Workspace analysis; Work envelope andexamples; Workspace fixtures; Trajectory planning; Joint-space trajectory planning;Cartesian-space trajectories; Pick and place operations; Continuous path motion;Interpolatedmotion;Straight-line motion.	08
3.	**Velocity kinematics & dynamics:**Differential motions and velocities: Differentialrelationship; Jacobian; Differential motion of a frame and robot; Inverse Jacobian;Singularities;Dynamicanalysisofforces:Lagrangianmechanics;NewtonEuler formulation;Dynamicequationsoftwoaxisrobot.	07
4.	**Robotvision:**Imagerepresentation;Templatematching;Polyhedralobjects;Shapeanalysis;Segmentation;Iterativeprocessing;Perspectivetransform;Camera calibration.	06
5.	**Taskplanning:**Tasklevelprogramming;Uncertainty;Configurationspace;Gross motionplanning;Graspplanning;Fine-motionplanning;Simulationofplanermotion; Sourceand goalscenes;Taskplanner simulation.	06
6.	**Applicationsinbiomedicalengineering:**Applicationinrehabilitation,clinicalmedicine and surgery.	05

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

TextBooks:

1. FundamentalsofRobotics-Analysisandcontrol,RobertShilling,PrenticeHallofIndia
2. IntroductiontoRobotics,SaeedBNiku,PearsonEducation
3. Robotics,Fu,GonzalesandLee, McGrawHill, SecondEdition,2011
4. "IntroductiontoRobotics–Mechanics&Control"JohnJ.Craig,PearsonEducation,India,(3rd Ed)

ReferenceBooks:

1. RoboticsandAI,Staughard,PrenticeHall OfIndia.
2. IndustrialRoboticsGrover,Wiess,Nagel,Oderey,McGrawHill.
3. RoboticsandMechatronics,WalframStdder,McGrawHill,NewYork,2008
4. RobotEngineering,Klafter,Chmielewski,Negin.PrenticeHallOfIndia.
5. RoboticsandControl.Mittal,Nagrath,TataMcGrawHillpublications

SubjectCode	SubjectName	Credits
BMPE2013	**NeuralNetworks**	**03**

CourseObjective:

- To understand the basic concepts of artificial neural network (ANN),study the various ANNModels, study single layer and multilayer feed forward neural networks, familiarize about thesupportvector machineand adaptiveresonancetheory, studythebasic conceptsof Fuzzysetsandsystem, learn ANNin biomedical applications

CourseOutcome:

- ALearnerwillbeabletoapplyconceptsofANN inBiomedicalapplications,applyconceptsofFuzzySets in Biomedical applications

Module	Detailedcontent	Hours
1	**Introduction to neural networks:** Introduction; Humans and computers;Organizationofthebrain;Biologicalneuron;Biologicalandartificial neuronmodels;CharacteristicsofANN;McCulloch-Pittsmodel; Historicaldevelopments;PotentialapplicationsofANN.	05
2	**Essentialsofartificialneuralnetworks:**Artificialneuronmodel;Operations of artificial neuron; Types of neuron activation function; ANNarchitectures;Classificationtaxonomyof ANNconnectivity;Learning strategy(supervised,unsupervised,reinforcement);Learningrules.	07
3	**Singlelayerandmulti-layerfeedforwardneuralnetworks:**Introduction;Classificationofperceptronmodels:Discrete,continuousand multi-category training and classification using discrete perceptrons;Algorithm examples;Linearly separable classifications; Multi-categorysinglelayerperceptron networks; Linearlynon-separableclassification; Delta learning rule; Feed forward recall and error back-propagationtraining;Learningfactors;Kolmogorovtheorem;Learning difficultiesandimprovements.	08
4	**Specialnetworks:**Introduction;Adaptiveresonancetheory(ART)fundamentals; ART1, ART2; Support vector machine (SVM) introduction;Optimalhyperplaneforlinearlyseparableandnon-separablepatterns; SVMforpatternrecognitionandnonlinearregression;Radialbasisfunctionnetworkarchitectureand trainingalgorithm.	07
5	**Classical & fuzzy sets and fuzzy logic system components:** Introductiontoclassicalsets;Properties,operationsandrelations;Fuzzysets,membership,uncertainty,operations,properties;Fuzzyrelations,cardinalities,membershipfunctions,fuzzification,membershipvalueassignment;Developmentofrulebaseanddecisionmakingsystem; De-fuzzificationtocrispsets;De-fuzzificationmethods.	08
6	**Neural networks applications in biomedical:** Brain maker to improvehospitaltreatmentusingadaline;BreastcancerdetectionusingARTnetwork;Accesscontrolbyfacerecognitionusingbackpropagationneural network.	04

Assessment

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TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

TextBooks:

1. S.RajasekharanandG.A.Vijayalakshmipai,"NeuralNetworks,Fuzzylogic,Geneticalgorithms: synthesisand applications",PHIPublication, 2004.
2. JohnYenandRezaLangan,"FuzzyLogic:Intelligence,ControlandInformation",PearsonEducation,2004.

ReferenceBooks:

1. SimonHaykin,"NeuralNetworks-Acomprehensivefoundation",PearsonEducation,2001.
2. S.N.Sivanandam,S.Sumathi,S.N.Deepa"IntroductiontoNeuralNetworksusingMATLAB6.0",TMH,2006.
3. JamesAFreemanandDavisSkapura,NeuralNetworksPearsonEducation,2002.
4. TimothyJ.Ross,"FuzzyLogicWithEngineeringApplications",McGraw-HillInc.1997.

SubjectCode	SubjectName	Credits
BMPE2021	**ComputerNetworking inMedicine**	**03**

CourseObjective:

- Tounderstandvarioustechniquesfordatacommunicationanddatatransfer Enabletheleanertoknowabout Application LayerDataLinkLayerNetworkLayerTransportLayer

CourseOutcome:

- Learner will be able to apply his knowledge regarding computer networking takes place in medicine byApplicationLayerDataLinkLayer NetworkLayer,TransportLayerin healthcare.

Module	Detailedcontent	Hours
1	**Data communications:** Components, direction of data flow networks; Componentsand categories; Types of connections; Topologies, protocols and standards - OSImodel,TCP/IP protocol.	05
2	**Datatransmission:**Transmissionmedia:coaxialcable,fiberoptics,linecoding; Modems– RS232interfacingsequencescircuitswitching,throughput,bandwidth,T1,ISDN, DSL.	05
3	**Data link layer:** Types of errors, error detection and correction methods; Blockcodes, cyclic codes, checksum data link; Control protocols, stop and wait, go back-NARQ,selective repeat ARQ,HDLC.Wired and wireless, connecting LANs,Backbonenetworks LANLAN/WAN.	07
4	**Networklayer:**Internetworks;Packetswitchinganddatagramapproach;IP addressing methods;Sub-netting, routing,distancevectorrouting,linkstaterouting;Routers.	07
5	**Transport layer:** Duties of transport layer; Multiplexing, de-multiplexing; Sockets;User datagram protocol (UDP); Transmission control protocol (TCP); Congestioncontrol; Qualityof services(QOS). **Applicationlayer:**Domainnamespace(DNS),SMTP,FTP,HTTP,WWW,SNMP.	11
6	**Security concepts:** System security in general; Authentication, authorization,confidentiality,integrity, cryptography.	04

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

TextBooks:

1.Computer Network–BehrouzA.Forouzan,McGrawHill.

ReferenceBooks:

1.Computer Networks–AndrewS.Tanenbaum

SubjectCode	SubjectName	Credits
BMPE2022	LasersandFiberOpticsin Medicine	03

CourseObjective:

- ToUnderstandthebasicPhysicsofgenerationoflasers,TypesofLasers,itsconstruction,generalconstructionofOpticfiber, Modesandneedof Laser and fiberopticsinmedicine.

CourseOutcome:

- It enables the learnertounderstandthe Types of laser anditsMedicalapplicationsandvarioussafetyaspects and troubleshooting

Module	Detailedcontent	Hours
1	**Introduction:**Historicalbackground;Medicallasersfundamentalprinciplesandadvances; Laser safety;Interactionwith tissue; Laser assisteddiagnosis.	07
2	**Singleopticalfibers:**Introduction;Historicalbackground;Opticalfibersfundamentals; Light transmission in optical fibers: principles, optical properties ofoptical fibers; Fabrication of optical fibers, optical fibers for UV, visible, IR light;Power transmission through optical fibers; Modified fiber ends and tips-principles;Fiberlasers-advances.	08
3	**Optical fiber bundles:** Non-ordered fiber optic bundles for light guides fundamentals&principles;Orderedfiberopticbundlesforimagingdevices Fundamentals& principles; Fiberscopes and endoscopes fundamentals, fiber optic imaging systemsadvances.	06
4	**Applicationsoflasersintherapyanddiagnosis:**Introduction;Laserassisteddiagnosisand therapy-fundamentals; Interaction oflaserbeamsand materials.	06
5	**Clinical applications of fiber optic laser system in medicine:** Introduction, Fiberopticlasersystemsincardiovasculardisease; Applications in gastroenterology,gynecology,oncology,ophthalmology,orthopedics,otolaryngology(ENT)andurology.	07
6	**Clinical applications of fiber optic laser system in invasive procedures:** Minimalinvasive laser spine surgery; Neurosurgery; Flow diagram for laser angioplasty &photodynamictherapy;Endoscopy.	05

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or course project.

TheoryExamination:

1. Questionpaperwillcompriseoftotal06questions,eachcarrying20marks.
2. Total04questionsneedtobesolved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarks will beasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

TextBooks:

1. LasersandOpticalFibersinMedicine –AbrahimCatzirAcademicpress 1998.

ReferenceBooks:

1. TherapeuticLasers–GDavidBaxter –ChurchillLivingstonepublications
2. MedicalLaserandtheirsafeuse–DavidHShinyStiffenandLTrokelSpringerPublications
3. ElementofFiberoptics–S.L.Wymer RegentsPHI

SubjectCode	DepartmentalElectiveCourse:SubjectName	Credits
BMPE2023	**InternetofThingsinMedicine**	**03**

Courseobjectives:

- TounderstandsmartobjectsandIoTarchitectures.
- TolearnaboutvariousIoTrelatedprotocols.
- TobuildsimpleIoTsystemsusingArduino&RaspberryPi.
- Tounderstanddata analyticsand cloudincontextof IoT.
- TodevelopIoTinfrastructureforpopular applications.

Courseoutcome: Learnerwillbeableto:

- Explaintheconceptof IoT.
- AnalyzevariousprotocolsforIoT.
- Design aPoCofandIoT systemsusingRaspberryPi/Arduino.
- ApplydataanalyticsanduseclоudofferingsrelatedtoIoT.
- AnalyzeapplicationsofIoTinrealtimescenario.

Module	DetailedContents	Hours
1	**FundamentalsofIoT:**EvolutionofInternetofThings;Enablingtechnologies;IoT architectures: oneM2M, loT World Forum (loTWF) andalternativeloTmodels;SimplifiedloTarchitectureandcore;loTfunctional stack.	6
2	**IoT protocols:** IoT access technologies: physical and MAC layers, topologyand security of IEEE 802.15.4e, 1901.2a, 802.11ah & LoRaWAN; Networklayer:IPversions,routingoverlowlossynetworks;Applicationtransport methods:supervisorycontrolanddataacquisitionapplication;Layerprotocols:MQ TT.	6
3	**CloudplatformsforIoT:**Virtualizationconceptsandcloudarchitecture;Cloudcom putingbenefits;Cloudservices-SaaS,PaaS,IaaS,cloudproviders &offerings;StudyofIoTcloudplatforms.	6
4	**Engineering IoT networks:** Functional blocks of an loT ecosystem, sensors,actuators; Smart objects connecting; Smart objects range; Frequency bands,powerconsumption,topology;Constraineddevices,constrainednode networks;Datarateandthroughput,latencyanddeterminism.	6
5	**Applications of IoT in medicine (Part I):** NSUM technique for diabetespatients; Healthcare monitoring system through cyber-physical system; An loTmodelforneurosensors;AdaBoostwithfeatureselectionusingloTfor somaticmutationsevaluationincancer;Afuzzy-basedexpertsystemtodiagnoseAlzheimer'sdisease.	8
6	**ApplicationsofIoTinmedicine(PartII):**SecuredarchitectureforloTenabled personalized healthcare systems; Healthcare application developmentinmobileandcloudenvironments;Approachtopredictdiabeticretinop athy throughdataanalytics;Diagnosisofchestdiseasesusingartificialneuralnetworks.	7

Text Books

1) DavidHanes,GonzaloSalgueiro,PatrickGrossetete,RobBartonandJeromeHenry,"loTFundamentals: Networking Technologies, Protocols and Use Cases for lnternet of Things, CiscoPress,2017.
2) VenkataKrishna,SasikumarGurumoorthy,MohammadS.Obaidat,"lnternetofThingsandPersonalized Healthcare Systems", Springer Briefs in Applied Sciences, and Technology, ForensicandMedicalBioinformatics,2019.

ReferenceBooks

1. ArshdeepBahga, Vijay Madisetti, "lnternet of Things – A hands-on approach", Universities Press,2015
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications andProtocols",Wiley,2012.
3. Jan Holler, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. DavidBoyle,"FromMachine-to-MachinetotheInternetofThings– IntroductiontoaNewAgeofIntelligence",Elsevier,2014.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things",Springer,2011.

Assessment

InternalAssessmentconsistsoftwotestsoutofwhich;oneshouldbecompulsoryclasstest(onminimum02Modules)andtheotheriseitheraclasstestorassignmentonlive problems or courseproject.

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3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions ofmarkswillbeasked.
4. Remainingquestionswill berandomlyselectedfromall themodules.

3.

SubjectCode	LaboratoryName	Credits
BML201	**ProgramLaboratoryII**	**01**

Module	Practicalsbasedon
1	Filteringinfrequencydomain
2	Filteringinspatialdomain
3	Skeletonisation
4	Biomedicalimagecompression
5	Reconstructionusingfilterbackprojection
6	Reconstructionusingalgebraictechnique
7	Featureextraction
8	Statisticalprocessing(histogram,rescaling)

Termwork: Termworkconsistsofperforming08practical mentionedasabove.Final certificationandacceptanceof the termworkensuressatisfactoryperformanceoflaboratorywork.

Assessment:

EndSemesterExamination: Practical/Oralexaminationistobeconductedbypairofinternalandexternal examiners.

SubjectCode	LaboratoryName	Credits
BMSBL201	**SkillBasedLaboratoryII**	**02**

Module	Practicalsbasedon
1	OperatingECGmachineusingsimulator
2	RecordingofTele ECG
3	Peripheralpulseanalysis
4	Peristalticpumpunderstanding
5	Automationcomponentsrelays,timersetc
6	AssemblingECGusingAD8232
7	Assemblingoximeter usingMAX30102
8	MeasurementofpulseinoscillometricBP

Termwork: Termworkconsistsofperforming08practicalmentionedasabove.Finalcertificationandacceptanceof the termworkensuressatisfactoryperformance oflaboratorywork.

Assessment:

EndSemesterExamination: Practical/Oralexaminationistobeconductedbypairofinternalandexternalexaminers.

SemesterIII

Course Code	CourseName	Teaching Scheme(Contact Hours)			CreditsAssigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMMP301	MajorProject: Dissertation-I	--	20	--	--	10	--	10
Total		**00**	**20**	**00**	**00**	**10**	**--**	**10**

Course Code	CourseName	ExaminationScheme							
		Theory					TermWork	Pract/Oral	Total
		InternalAssessment			EndSem.Exam	Exam. Duration(in Hrs)			
		Test-1	Test-2	Avg					
BMMP301	MajorProject: Dissertation-I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	--	**100**	**--**	**100**

OnlineCreditCourses

Course Code	CourseName	Teaching Scheme(Contact Hours)			CreditsAssigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMOCC301	OnlineCreditCourse-I	--	--	--	--	--	--	3
BMOCC301	OnlineCreditCourse-II	--	--	--	--	--	--	3
Total		**--**	**--**	**--**	**00**	**00**	**00**	**06**

Note 2: It is mandatory to complete the Online Credit Courses (OCC) available on NPTEL /Swayam /MOOC or similar platform approved by UoM. These two courses shall be completed inany semester I or II or III, but not later end of the Semester III.University shall make a provisionthat credits earned withOCC-I and OCC-II shall be accounted in thethird semestergrade-sheetwith actual names of courses. The learner shall be allowed to take up these courses from his or herinstitute or organisation/ industry where his / her major project is carried out. The students shallcomplete the courses and shall qualify the exam conducted by the respective authorities/ instructorfrom the platform. The fees for any such courses and the corresponding examination shall be bornebythe learner.

OnlineCreditCourse –I

Thelearnershalloptforthecourseinthedomainof ResearchMethodology **or** Research&PublicationEthicsor IPR. Theopted courseshall beof 3credits ofequivalent numberofweeks.

OnlineCreditCourse–II

Thelearnershalloptforthecourserecommended byFacultyAdvisor/ProjectSupervisorfromtheinstitute.T heopted courseshall beof 3credits of equivalent number of weeks.

SemesterIV

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMMP401	Major Project :Dissertation-II	--	32	--	--	16	--	16
Total		--	**32**	--	--	**16**	--	**16**

Course Code	CourseName	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration(in Hrs)			
		Test -1	Test -2	Avg					
BMMP401	MajorProject: Dissertation-II	--	--	--	--	--	100	100	200
Total		--	--	--	--	--	**100**	**100**	**200**

TotalCredits:68

Note3: TheDissertation-IIsubmissionshallnotbepermittedtillthelearnercompletesalltherequirementsME course.

Note4: Thecontact hours forthe calculationof load oftheteacherfor Major Projectareasfollows:MajorProject DissertationIandII-02 Hour/ week / student

GuidelinesforAssessmentofDissertation-I

Studentsshoulddoliteraturesurveyandidentifytheproblemfor Dissertationandfinalizeinconsultation with Guide/Supervisor. Students should use multiple literatures and understand theproblem. Students should attempt solution to the problem by analytical/simulation/experimentalmethods. The solution to be validated with proper justification and compile the report in standardformat.

Dissertation-Ishould beassessedbased on followingpoints

- Qualityofliteraturesurveyand noveltyin theproblem
- Clarityofproblem definition and feasibilityofproblem solution
- Relevancetothespecialization
- Clarity of objective and scope Dissertation-I should be assessed through a presentation by a panelof Internal examiners and external examiner appointed by the Head of the Department/Institute ofrespectiveProgramme.

GuidelinesforAssessmentofDissertation II

DissertationIIshouldbeassessedbased onfollowingpoints:

- Qualityofliteraturesurveyandnoveltyintheproblem
- Clarityof problem definitionand feasibilityofproblem solution
- Relevancetothespecializationorcurrentresearch/industrial trends
- Clarityofobjectiveand scope
- Qualityof workattemptedorlearnercontribution
- Validationofresults
- Qualityof writtenandoralpresentation

Studentsshouldpublishatleastonepaperbasedontheworkinreferred National/Internationalconference/Journalof repute.

DissertationII shouldbeassessedbyinternalandexternalexaminersappointedbytheUniversityofMumbai.