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(Under Maharashtra Act No. XXIX of 2014)
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Course Structure and Detailed Syllabus

of

B. Tech Programme

for

Biomedical Engineering

from

Second Year Engineering

In line with National Education Policy 2020

Effective from Academic year 2025-26 for affiliated colleges

Department of Biomedical Engineering

Credit Framework under Four-Years UG Engineering Programme with Multiple Entry and Multiple Exit options:

- The Four-year Bachelor's Multidisciplinary Engineering Degree Programme allows the students to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices and the feasibility of exploring learning from different institutions.
- The minimum and maximum credit structure for different levels under the Four-year Bachelor's Multidisciplinary Engineering UG Program with multiple entry and multiple exit options are as given below:

Credit Framework

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	One Year UG Certificate in Engg./ Tech.	40	44	2	1
5.0	Two Years UG Diploma in Engg./ Tech.	80	88	4	2
5.5	Three Years Bachelor's Degree in Vocation (B. Voc.) or B. Sc. (Engg./ Tech.)	120	132	6	3
	4-Years Bachelor's degree				

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
6.0	(B.E./ B.Tech. or Equivalent) in Engg./ Tech. with Multidisciplinary Minor	160	176	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors with Research and Multidisciplinary Minor	180	194	8	4
6.0	4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Major Engg. Discipline with Double Minors (Multidisciplinary and Specialization Minors)	180	194	8	4

- There are multiple exit options at each level. Student will be given a specific Qualification mentioned in the table depending on the level at which he/she decides to have an exit. Ex. If a student decides to exit after completion of two years (level 5.0) of the program, he will be given a Diploma in Engineering with specific exit condition mentioned in the syllabus of the specific branch. He/she can rejoin the program with the multiple entry option at the level next where he/she chose to exit previously. (Student can join at level 5.5 if successfully completed level 5.0 previously at the time of exit).
- Minimum credit requirements of each level are mentioned in the credit framework table.

- There are 4 distinct options available at level 6.0.
- First one is basic level 6.0 option where minimum 160-maximum 176 credits are mandatory which can be completed as per the Semester-wise Credit distribution structure mentioned in the table given below.

  Here, the Bachelor's Engineering Degree in chosen Engg./ Tech. Discipline with multidisciplinary minor (min.160-max.176 Credits) i.e. "**B. Tech in Biomedical Engineering with Computer Engineering**" (160-176 credits) enables students to take up five-six or required additional courses of 14 credits in the discipline other than Biomedical Engineering distributed over semesters III to VIII. Here in the case of "**B. Tech in Biomedical Engineering with Computer Engineering**" (160-176 credits) student is supposed to take up 50% or more courses to complete the 50% or more credits (from assigned 14 credits) from **Computer Engineering minor bucket**. The remaining courses to complete the assigned 14 credits can be covered from other discipline's minor buckets.
- Remaining three level 6.0 options are the advanced options where the student is given an opportunity to get extra qualification by earning some extra credits (18-20 extra credits). These three options are given below:
- Level 6.0: The **Bachelor's Engineering Degree with Honours** in chosen Major Engg. / Tech. Discipline i.e. in Biomedical Engineering with Honours with Multidisciplinary Minor (180-194 credits) enables students of Biomedical Engineering to take up five-six additional courses of 18 to 20 credits in the Biomedical Engineering discipline distributed over semesters III to VIII. The decision regarding the mechanism of distribution of these 18-20 credits over semesters III to VIII, which are over and above the min.160-max.176 Credits prescribed for the duration of four years will be taken by Academic Authorities of University. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option**.
- Level 6.0: The **Bachelor's Engineering Degree with Research** in i.e. in Biomedical Engineering with Research with Multidisciplinary Minor (180-194 credits) enables students of Biomedical Engineering to take up a research project of 18 to 20 credits in the Biomedical Engineering discipline distributed over semesters VII to VIII. **Student must have CGPA equal to or greater than 7.5 at the end of sixth semester to go for this option**.
- Level 6.0: The **Bachelor's Engineering Degree in chosen Engg. / Tech. Discipline with Double Minor** (Multidisciplinary and Specialization Minor, 180-194 credits), i.e. "**B. Tech in Biomedical Engineering with *other selected discipline in* Engineering (as MDM) with Specialization Minor in Computer Engineering**" (180-194 credits) enables students to take up five-six additional courses of 14 credits in the discipline other than Biomedical Engineering (for completion of multidisciplinary minor) and 18 to 20 extra credits in the **Computer Engineering discipline** distributed over semesters III to VIII. Here, the ***other selected discipline* in Engineering should be different from Specialization Minor i.e. Computer Engineering**. This enables students to take up five-six or required additional courses of 18 to 20 credits in the **Computer Engineering** discipline distributed over semesters III to VIII, which are over and above the min.160-max.176 Credits. The decision regarding the mechanism of distribution of these 18-20 credits over

semesters III to VIII, prescribed for the duration of four years will be taken by Academic Authorities of University. **Student must have CGPA equal to or greater than 7.5 at the end of second semester to go for this option**.

Semester-wise Credit distribution structure for Four Year UG Engineering Program - One Major, One Minor

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	06-08	08-10		--	--	--	--	--	14-18
Engineering Science Course		10-08	06-04		--	--	--	--	--	16-12
Programme Core Course (PCC)	Program Courses	--	02	08-10	08-10	10-12	08-10	04-06	04-06	44-56
Programme Elective Course (PEC)		--	--	--	--	04	08	02	06	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses		-	02	02	04	02	02	02	14
Open Elective (OE) Other than a particular program		--	--	04	02	02	--	--	--	08
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	02	02	--	02	--	02	--	--	08
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	02	--	--	02	--	--	--	--	04
Entrepreneurship/Economics/ Management Courses		--		02	02	--	--	--	--	04
Indian Knowledge System (IKS)			02		--	--	--	--	--	02
Value Education Course (VEC)		--	--	02	02	--	--	--	--	04
Research Methodology	Experiential Learning Courses	--	--	--	--	--	--		04	04
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	02	--	--	--	-	-	02
Project		--	--	--	--	--	--		04	04
Internship/ OJT		--	---			--	--	12	-	12
Co-curricular Courses (CC)	Liberal Learning Courses	02	02		--	--	--	--	-	04
Total Credits (Major)		**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**160-176**

Student need to follow the Semester-wise Credit distribution structure for Four Year UG Engineering Program as prescribed in the table given above.

- There are seven vertical categories with specific credits distributed in specific semesters.
- Student can choose a Program Elective Course (PEC) in that specific semester from the given subjects.
- Multidisciplinary course (MDM) and Open Elective (OE) courses can be chosen from the MDM and OE Buckets depending on students' choice. Completion of total credits given in the last column of the table for each vertical is mandatory.
- Students can complete 40% of the courses through online platforms like NPTEL/SWAYAM. The NPTEL SWAYAM course content should be at least 80% similar to the course content in the syllabus.

General 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:
   i) Satisfied all the Academic Requirements to continue with the programme of Studies without termination
   ii) Cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
   iii) Paid all required advance payments of the Institute and hostel for the current semester;
   iv) 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 implemented from academic year 2023-24, from I year B. Tech.

Percentage 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 awarded based on CGPA of all eighth semester of B.Tech Program.

CGPA for pass is minimum 5.0	
CGPA upto <5.50	Pass class
CGPA ≥ 5.50&<6.00	Second Class
CGPA ≥ 6.00&<7.5	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:

Mid Semester Exam (MSE) Marks	20
Continuous Assessment Marks	20
End Semester Examination(ESE)Marks	60

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

1.	Continuous Assessment 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, M. Tech to score a minimum of 45 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 2023-24

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 students 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

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,

„c_i" is the number of credits allotted to a particular subject, and

„g_i" 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.

7. Attendance Requirements:

a. All students must attend every lecture, tutorial and practical classes.

b. 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%.

c. 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.

d. The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

8. 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.

SECOND YEAR

	Course Code	Course Title	L	T	P	Examination Scheme			Cr	Categorization
						CA	MSE	ESE		
SEM III	25AF1000BS301	Engineering Mathematics-III	3	0	0	20	20	60	3	BSC
	25AF1461PC302	Human Anatomy and Physiology	3	0	0	20	20	60	3	PCC
	25AF1461PC303L	Human Anatomy and Physiology Lab	0	0	2	60		40	1	PCC Lab
	25AF1461PC304	Analog and Digital Circuits	3	0	0	20	20	60	3	PCC
	25AF1BMEOE305	**Open Elective Bucket****	2	0	0	20	20	60	2	OE
	25AF1461MD306	**MDM Bucket*** Network Theory	2	0	0	20	20	60	2	MD Minor
	25AF1000AE307A 25AF1000AE307B	A. Employability and Skill Development B. Innovation and Entrepreneurship	2	0	0	20	20	60	2	Entrepreneurship
	25AF1000VE308A	Life of Chhatrapati Shivaji Maharaj	1	0	0	50			1	VEC
	25AF1461PC309L	Analog and Digital Circuits Lab	0	0	2	60		40	1	PCC Lab
	25AF1UHVVE310	Universal Human Values II	3	0	0	20	20	60	3	VEC
	25AF1461CP311	Biomedical Clinical Engineering Project (CEP)	0	0	4	60		40	2	CEP/FP
			19	**0**	**8**					
			Total						**23**	

NOTE: * Refer to Multidisciplinary Minor Bucket

**** Refer to Open Elective Bucket**

	Course Code	Course Title	L	T	P	Examination Scheme			Cr	Categorization
						CA	MSE	ESE		
SEM IV	25AF1461PC401	Biomedical Instrumentation	3	0	0	20	20	60	3	PCC
	25AF1461PC402	Biomechanics	3	0	0	20	20	60	3	PCC
	25AF1461PC403	Bio-Signal Processing	3	0	0	20	20	60	3	PCC
	25AF1461PC404L	Bio-Signal Processing Lab	0	0	2	60		40	1	PCC Lab
	25AF1BMEOE405	**Open Elective Bucket****	3	0	0	20	20	60	3	OE
	25AF1461MD406	**MDM Bucket*** Data Science & Machine Learning	2	0	0	20	20	60	2	MD Minor
	25AF1COIVE407	Constitution of India	2	0	0	50			AU	VEC
	25AF1000VE408B	Life of Bharatratna Dr. Babasaheb Ambedkar	1	0	0	50			1	VEC
	25AF1000HM409	Patents and IPR	2	0	0	20	20	60	2	Entrepreneurship
	25AF1000AE410A 25AF1000AE410B 25AF1000AE410C	A. Marathi B. Hindi C. Sanskrit	2	0	0	20	20	60	2	HSSM
	25AF1461VS411	Biomedical Prototype Designing	0	0	4	60		40	2	VSEC
	25AF1461PC412L	Biomedical Instrumentation Lab	0	0	2	60		40	1	PCC Lab
	25AF1461PC413L	Biomechanics Lab	0	0	2	60		40	1	PCC Lab
			21	**0**	**10**					
			Total						**24**	

NOTE: * Refer to Multidisciplinary Minor Bucket

**** Refer to Open Elective Bucket**

Multidisciplinary Minor (MDM) Bucket in Biomedical Engineering

Course Code	Course	Credit	Disciplines involved
25AF1461MD306	Network Theory	2	Electronics, Electrical, E&TC
25AF1461MD406	Data Science & Machine Learning	2	Computer Science and Engineering, Electronics, Electrical, E&TC
25AF1461MD506	Neuroscience	3	Biology, Psychology, Cognitive Science
25AF1461MD606	Healthcare Informatics	3	Electrical Engineering, , Computer Science and Engineering
25AF1461MD706	Robotics and Control Systems	2	Electrical Engineering, Mechanical Engineering, Computer Science and Engineering
25AF1461MD804	Biomedical Product Development	2	Electrical Engineering, Mechanical Engineering, Computer Science and Engineering

Open Elective Bucket in Biomedical Engineering

Course Code	Open Elective	Credit	Courses
25AF1BMEOE305A	Public Health & Healthcare Management	2	A. Introduction to Public Health
25AF1BMEOE305B		2	B. Health Economics
25AF1BMEOE305C		2	C. Healthcare Systems Management
25AF1BMEOE405A	Robotics & Embedded Systems	3	A. Embedded Systems and IoT
25AF1BMEOE405B		3	B. Mechatronics for Medical Devices
25AF1BMEOE405C		3	C. Fundamentals of Robotics
25AF1BMEOE505A	AI & Data Science in Healthcare	3	A. Machine Learning for Biomedical Applications
25AF1BMEOE505B		3	B. Biostatistics and Data Analytics
25AF1BMEOE505C		3	C. Deep Learning for Medical Diagnostics

Credit Distribution

SEM I	SEM II	SEM III	SEM IV	SEM V	SEM VI	SEM VII	SEM VIII	TOTAL
24	23	23	24	23	19	23	19	178

For Degree completion : Students must complete min 08 Credits of Open Elective, 20 Credits of Program Elective, 14 Credits of HSSM, 4 credits of co-curricular courses and 22 credits of Experiential learning courses from Open courses slots Institutes are free to manage the slots according to BoS inputs.

Note: Students can complete online courses of 40% of total credits through online platform NPTEL / SWAYAM/ Sector Skill council of India and other online platforms identified by the University time to time. At least 80% contents of the NPTEL / SWAYAM/ Sector Skill council of India course should match with syllabus contents of the subject prescribed by the university.

BSC/ESC	Program Courses (PCC & PEC)	Multidisciplinary Courses (MDM & OE)	Skill Courses (VSEC)	Humanities Social Science and Management (HSSM) (IKS, VEC,AEC)	Experiential Learning Courses (CEP & FP)	Liberal Learning Courses (CC)	TOTAL
36	**69**	**22**	**9**	**14**	**24**	**4**	**178**

SECOND YEAR

SEMESTER III

25AF1000BS301	Engineering Mathematics-III	03 Credits

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 Network analysis.
2. Transforms such as Fourier transform, Laplace transform and applications to Communication systems and Signal processing.
3. Vector differentiation and integration required in Electro-magnetics and Wave theory.
4. Complex functions, conformal mappings, contour integration applicable to Electrostatics, Digital filters, Signal and Image processing.

Course Outcomes:

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

CO1: Solve higher order linear differential equation using appropriate techniques for modelling and analyzing electrical circuits.

CO2: Solve problems related to Fourier transform, Laplace transform and applications to Communication systems and Signal processing.

CO3: Obtain Interpolating polynomials, numerically differentiate and integrate functions, numerical solutions of differential equations using single step and multi-step iterative methods used in modern scientific computing.

CO4: Perform vector differentiation and integration, analyze the vector fields and apply to Electromagnetic fields.

CO5: Analyze conformal mappings, transformations and perform contour integration of complex functions in the study of electrostatics and signal processing.

Unit 1: Laplace Transform **09 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 delta function.

Unit 2: Inverse Laplace Transform **09 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.

Unit 3: Fourier Transform **09 Hours**

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

Unit 4: Partial Differential Equations and Their Applications **09 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 (), and one dimensional wave equation.

Unit 5: Functions of Complex Variables **09 Hours**

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic function sin Cartesian form; Cauchy‟sin tegral theorem; Cauchy‟ sin tegral 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., New Delhi.
3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledge ware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, NewYork.
2. A Text Book of Engineering Mathematics by PeterO‟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 Knowledge ware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill , NewYork.

25AF11461PC302	Human Anatomy and Physiology	03 Credits

Course Objectives:

1.To understand the structure and function of the human body systems.
2.To relate the physiological processes with anatomical structures.
3.To apply anatomical and physiological concepts to biomedical engineering problems.
4.To provide a foundation for advanced biomedical courses.
5.To explore the integration of organ systems in maintaining homeostasis.

Course Outcomes (COs):

After successful completion of this course, the student will be able to:

CO1: Describe the organization and structure of the human body and its organ systems.
CO2: Explain the physiology of key systems including circulatory, respiratory, nervous, and musculoskeletal systems.
CO3: Analyze the interaction and regulation of body systems in health and disease.
CO4: Apply knowledge of anatomy and physiology in interpreting biomedical signals and designing medical devices.
CO5: Demonstrate understanding of the integration of physiological systems to maintain homeostasis.

Unit 1: Introduction to Human Anatomy & Physiology

Levels of structural organization, Anatomical terminology, planes, and body cavities, Cell structure and function, Tissues – classification and characteristics,Membranes and glands

Unit 2: Skeletal and Muscular Systems

Bone structure and types, Skeleton – axial and appendicular, Joints – types and movements, Overview of muscle tissue types, Mechanism of muscle contraction, Musculoskeletal disorders

Unit 3: Nervous and Endocrine Systems

Central and Peripheral Nervous Systems, Structure and function of neurons, Brain and spinal cord anatomy, Autonomic nervous system, Endocrine glands and hormones, Hormonal regulation and feedback mechanisms

Unit 4: Cardiovascular and Respiratory Systems

Heart structure, cardiac cycle, and conduction system, Blood vessels – types and circulation, Blood composition and functions, Pulmonary and systemic circulation, Structure and function of respiratory organs, Mechanism of breathing and gas exchange

Unit 5: Digestive, Urinary Systems

Structure and function of digestive organs, Digestive processes and nutrient absorption, Kidneys and nephron structure, Urine formation and water balance

Text Books:

1. **Tortora, G.J., & Derrickson, B.** – *Principles of Anatomy and Physiology*, Wiley, 14th Edition.
2. **Ross and Wilson** – *Anatomy and Physiology in Health and Illness*, Elsevier, 13th Edition.

Reference Books:

1. **Guyton, A.C., & Hall, J.E.** – *Textbook of Medical Physiology*, Elsevier, 13th Edition.
2. **Elaine N. Marieb & Katja Hoehn** – *Human Anatomy & Physiology*, Pearson, 11th Edition.
3. **Sembulingam & Prema Sembulingam** – *Essentials of Medical Physiology*, Jaypee Brothers.
4. **Chaurasia, B.D.** – *Human Anatomy (Volumes 1–4)*, CBS Publishers.

25AF11461PC303L	Human Anatomy and Physiology Lab	01 Credits

Human Anatomy and Physiology – Laboratory Experiments

Lab 1: Introduction to Human Anatomy

Study of anatomical terms, planes, and body positions using charts and models, Identification of major human bones and muscles using skeleton models

Lab 2: Microscopic Study of Tissues

Histological examination of epithelial, connective, muscle, and nervous tissues under the microscope, Identification of tissue types and their characteristics using stained slides

Lab 3: Musculoskeletal System

Demonstration of bones from axial and appendicular skeleton, Observation of different types of joints and range of motion, Surface anatomy of major muscles and joints

Lab 4: Nervous System

Study of brain and spinal cord models with identification of major structures, Reflex testing (e.g., knee-jerk reflex) to understand neural pathways, Demonstration of cranial and spinal nerves using charts/models

Lab 5: Endocrine System

Observation and identification of endocrine glands in anatomical charts, Case study or simulation: role of insulin and feedback control in glucose regulation

Lab 6: Cardiovascular System

Measurement of blood pressure using a sphygmomanometer, Pulse rate measurement under resting and exercise conditions, Study of heart structure using models and charts

Lab 7: Respiratory System

Measurement of lung volumes and capacities using a spirometer, Study of respiratory tract anatomy using charts and models, Simulation of gas exchange and respiration processes

Lab 8: Digestive System

Identification of digestive organs on torso models, Observation of digestion-related processes using multimedia or enzyme experiments (e.g., starch breakdown), Case study: disorders like acidity or ulcers and related physiological concepts

Lab 9: Urinary System

Study of kidney and nephron structure using models and diagrams
Urinalysis: physical characteristics of urine (color, pH, specific gravity)
Demonstration: water balance and osmoregulation

25AF11461PC304	Analog and Digital Circuits	03 Credits

Course Objectives

1. To introduce semiconductor devices and their applications in biomedical electronics
2. To develop the ability to analyse and design analog circuits such as amplifiers and filters
3. To familiarize students with operational amplifiers and their use in signal conditioning
4. To impart knowledge of digital logic circuits used in control and data processing
5. To prepare students to integrate analog and digital systems for biomedical applications

Course Outcomes (COs)

CO1: Explain the characteristics and operation of semiconductor devices such as diodes, BJTs, and FETs
CO2: Analyse and design basic analog circuits including rectifiers, amplifiers, and filters
CO3: Apply operational amplifiers in linear and non-linear biomedical signal processing circuits
CO4: Design and analyse combinational and sequential digital logic circuits
CO5: Integrate analog and digital circuits for application in biomedical electronic systems

Unit 1: Semiconductor Devices and Diode Circuits

Semiconductor materials and diode characteristics, PN junction diodes, Zener diodes, LED and photodiodes, Diode circuits: rectifiers (half-wave, full-wave), voltage regulators
Clippers and clampers, Diode applications in biomedical signal conditioning

Unit 2: Transistors and Amplifiers

BJT and FET structure and operation, Biasing techniques and small signal models, Single-stage amplifier design and analysis, Frequency response of amplifiers, Amplifier applications in biomedical instrumentation

Unit 3: Operational Amplifiers and Applications

Op-amp architecture and ideal characteristics, Inverting and non-inverting amplifiers, Summing, differential, integrator, and differentiator circuits, Instrumentation amplifiers, Biomedical applications: ECG, EMG signal processing

Unit 4: Logic Gates and Combinational Circuits

Number systems and codes, Boolean algebra and simplification, Logic gates and truth tables, Karnaugh maps for logic minimization, Design of combinational circuits: adders, subtractors, multiplexers, demultiplexers, encoders, and decoders

Unit 5: Sequential Circuits and Digital Applications

Flip-flops: SR, JK, D, T, Counters: asynchronous and synchronous, Shift registers and timing diagrams, Basics of memory elements, Applications in digital control and biomedical data acquisition systems

Textbooks

1. Sedra, A. S., & Smith, K. C. – *Microelectronic Circuits*, Oxford University Press, 7th Edition
2. Floyd, T. L. – *Digital Fundamentals*, Pearson, 11th Edition

Reference Books

1. Millman, J., & Halkias, C. C. – *Electronic Devices and Circuits*, McGraw-Hill
2. Gayakwad, R. A. – *Op-Amps and Linear Integrated Circuits*, Pearson
3. Mano, M. M., & Ciletti, M. D. – *Digital Design*, Pearson
4. D.V. Hall – *Digital Circuits and Systems*, Tata McGraw-Hill

25AF1BMEOE305	**Open Elective Bucket**	**02 Credits**
25AF1BMEOE305A	**Introduction to Public Health**	**02 Credits**

Course Objectives

1. To introduce the concepts and scope of public health and its importance in society
2. To understand the determinants of health, disease prevention, and health promotion
3. To explore the structure and function of public health systems at national and global levels
4. To examine the role of biomedical engineers in public health technologies and services
5. To analyze case studies of public health interventions and strategies

Course Outcomes (COs)

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

CO1: Define the scope, objectives, and historical evolution of public health
CO2: Identify key determinants of health and disease, including environmental and social factors
CO3: Explain public health infrastructure, policies, and programs at local and global levels
CO4: Describe the role of surveillance, screening, and epidemiology in disease prevention
CO5: Apply public health principles to real-world biomedical and healthcare challenges

Unit 1: Fundamentals of Public Health

Definition, scope, and functions of public health, History and milestones in public health development, Core disciplines of public health: epidemiology, biostatistics, health education, and environmental health, Public health vs clinical care

Unit 2: Determinants of Health and Disease

Social, economic, behavioral, and environmental determinants, Concepts of risk factors, burden of disease, and vulnerable populations, Health disparities and health equity, Introduction to the concept of One Health (human-animal-environment interface)

Unit 3: Public Health Systems and Policies

Structure of public health systems in India and globally (e.g., WHO, CDC, MoHFW), National Health Programs and policies in India (e.g., NHM, NPCDCS), Health care delivery models: primary, secondary, tertiary care, Health care financing and insurance systems

Unit 4: Epidemiology and Disease Prevention

Basic concepts: incidence, prevalence, mortality, morbidity, Types of epidemiological studies: cohort, case-control, cross-sectional, Screening and surveillance systems, Immunization programs and outbreak investigation

Unit 5: Biomedical Engineering in Public Health

Biomedical devices and diagnostics for public health (e.g., portable diagnostics, sensors), Public health applications of telemedicine and health informatics, Role of biomedical engineers in health education and awareness campaigns, Case studies: innovations in maternal-child health, infectious disease control, rural health

Textbooks

1. Schneider, M. J. – *Introduction to Public Health*, Jones & Bartlett Learning
2. Park, K. – *Preventive and Social Medicine*, Banarsidas Bhanot Publishers

Reference Books

1. Turnock's *Public Health: What It Is and How It Works*, Jones & Bartlett
2. Scutchfield, F. D., & Keck, C. W. – *Principles of Public Health Practice*, Cengage
3. Friis, R. H., & Sellers, T. A. – *Epidemiology for Public Health Practice*, Jones & Bartlett
4. Detels, R., et al. – *Oxford Textbook of Global Public Health*, Oxford University Press

25AF1BMEOE305	**Open Elective Bucket**	**02 Credits**
25AF1BMEOE305B	**Health Economics**	**02 Credits**

Course Objectives

1. To introduce the fundamentals of economics applied to the health care sector
2. To understand how healthcare services are financed, delivered, and evaluated economically
3. To explore cost-effectiveness and efficiency in public health and biomedical technologies
4. To develop an understanding of market mechanisms in health care and government roles
5. To equip students to analyse economic aspects of biomedical innovations and healthcare systems

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Explain the core concepts of economics relevant to the healthcare sector

CO2: Analyze the demand and supply of healthcare services and health insurance

CO3: Evaluate the cost, efficiency, and outcomes of health interventions using economic tools

CO4: Interpret the role of government policy, regulation, and financing in healthcare economics

CO5: Apply health economic evaluation methods to biomedical engineering projects and health technologies

Unit 1: Introduction to Health Economics

Nature, scope, and objectives of health economics, Unique features of health and healthcare markets, Basic economic concepts: scarcity, opportunity cost, marginal analysis,Health as an economic good

Unit 2: Demand and Supply in Healthcare

Demand for healthcare: utility, price sensitivity, and income effects, Supply of healthcare services: role of hospitals, providers, pharmaceuticals, Elasticity of demand and its implications, Health insurance and its impact on demand

Unit 3: Healthcare Financing and Resource Allocation

Public vs. private healthcare financing, Health care expenditure and budgeting, Government funding mechanisms, insurance schemes (e.g., Ayushman Bharat), Principles of resource allocation and priority setting in health

Unit 4: Economic Evaluation of Health Technologies

Cost-effectiveness analysis (CEA), cost-utility analysis (CUA), cost-benefit analysis (CBA)

QALYs and DALYs in health economic assessment, Decision trees and sensitivity analysis

Case studies: evaluating medical devices and diagnostic tools

Unit 5: Health Policy, Equity, and Biomedical Innovation

Health economics and policy-making, Equity in access to healthcare and ethical considerations

Economics of biomedical innovations and technology adoption, Challenges in pricing and regulating biomedical products

Textbooks

1. Clewer, A., & Perkins, D. – *Economics for Health Care Management*, Routledge
2. Drummond, M. F., et al. – *Methods for the Economic Evaluation of Health Care Programmes*, Oxford University Press

Reference Books

1. Bhattacharya, J., Hyde, T., & Tu, P. – *Health Economics*, Palgrave Macmillan
2. Henderson, J. W. – *Health Economics and Policy*, Cengage
3. Folland, S., Goodman, A. C., & Stano, M. – *The Economics of Health and Health Care*, Pearson
4. Mills, A., & Gilson, L. – *Health Economics for Developing Countries*, London School of Hygiene

25AF1BMEOE305	**Open Elective Bucket**	**02 Credits**
25AF1BMEOE305C	**Health care System Management**	**02 Credits**

Course Objectives

1. To introduce the structure and functions of healthcare systems
2. To understand healthcare delivery models, planning, and management approaches
3. To explore health system performance, policy, and regulations
4. To integrate biomedical engineering principles with hospital operations and system planning
5. To prepare students for roles in healthcare administration, quality control, and biomedical service management

Course Outcomes (COs)

After successful completion of the course, the student will be able to:

CO1: Explain the components and functions of healthcare systems at national and global levels

CO2: Analyze various models of healthcare delivery and hospital administration

CO3: Evaluate hospital planning, infrastructure, and support service requirements

CO4: Apply principles of health care quality, accreditation, and regulation

CO5: Integrate biomedical engineering systems with health care operations and policy frameworks

Unit 1: Introduction to Health Care Systems

Overview of health care systems: components, goals, and challenges, Public and private healthcare systems in India and globally, Roles of WHO, MoHFW, and NGOs in health system delivery

Levels of healthcare: primary, secondary, and tertiary

Unit 2: Health Care Delivery and Hospital Organization

Types of hospitals: general, specialty, teaching, and research institutions, Organizational structure of hospitals and healthcare institutions, Functional departments: clinical, administrative, and support services, Biomedical engineer's role in hospital operations

Unit 3: Hospital Planning and Infrastructure

Hospital planning: site selection, layout design, space management, Planning of critical units: ICU, emergency, OT, diagnostics, Medical gas pipelines, waste management, infection control

Biomedical equipment planning and inventory management

Unit 4: Health Care Quality and Regulations

Quality assurance in healthcare: NABH, JCI, ISO standards, Patient safety and risk management

Medical ethics and legal compliance in hospitals, Health information systems and medical records management

Unit 5: Strategic and Technology Management in Health Systems

Health policy and planning: national health missions and insurance schemes, Health economics and resource allocation, Technology assessment and adoption in health care systems

Case studies: EHR systems, telemedicine integration, mobile health units

Textbooks

1. Sharon B. Buchbinder & Nancy H. Shanks – *Introduction to Health Care Management*, Jones & Bartlett Learning
2. S. L. Goel – *Health Care System and Hospital Administration*, Deep and Deep Publications

Reference Books

1. K. Park – *Park's Textbook Preventive and Social Medicine*, Banarsidas Bhanot
2. Mahadevan, B. – *Operations Management: Theory and Practice*, Pearson (for process integration concepts)

25AF1461MD306	**MDM Bucket**	**02 Credits**
25AF1461MD306	**Network Theory**	**02 Credits**

Course Objectives

1. To introduce the fundamentals of electrical networks and circuit laws
2. To analyze the behavior of linear circuits using various theorems and techniques
3. To understand transient and steady-state analysis for RLC circuits
4. To apply Laplace transform for circuit analysis in the frequency domain
5. To provide a foundation for analog electronics and biomedical signal pathways

Course Outcomes (COs)

After successful completion of this course, the student will be able to:

CO1: Apply network laws to analyze resistive circuits
CO2: Solve electrical networks using mesh, nodal, and network theorems
CO3: Analyze the transient behaviour of RLC circuits
CO4: Use Laplace transforms to solve electrical circuits in the s-domain
CO5: Understand resonance, coupled circuits, and two-port network parameters for practical applications

Unit 1: Basic Circuit Concepts

Ohm's law, Kirchhoff's laws, Series and parallel circuits, source transformation, Power and energy in electrical elements, Star-delta transformations, Network reduction techniques

Unit 2: Network Theorems and Analysis Techniques

Mesh and nodal analysis, Superposition theorem, Thevenin's and Norton's theorems
Maximum power transfer theorem

Unit 3: Transient Analysis of First and Second Order Circuits

RC, RL, and RLC circuits with step and impulse inputs, Natural and forced response of circuits
Time constants, damping, and resonance, Application to biomedical capacitive/resistive sensors

Unit 4: Laplace Transform and Frequency Domain Analysis

Laplace transform of basic signals and circuit elements, Initial and final value theorems
Circuit analysis using Laplace transforms, Transfer function, poles and zeros

Unit 5: Resonance and Two-Port Networks

Series and parallel resonance in RLC circuits, Quality factor, bandwidth, selectivity
Coupled circuits and dot convention, Two-port network parameters: Z, Y, h, parameters

Textbooks

1. Sudhakar, A., & Shyam Mohan, S. P. – *Circuits and Networks: Analysis and Synthesis*, McGraw Hill
2. Hayt, W. H., Kemmerly, J. E., & Durbin, S. M. – *Engineering Circuit Analysis*, McGraw Hill

Reference Books

1. Van Valkenburg, M. E. – *Network Analysis*, PHI
2. Joseph Edminister – *Schaum's Outline of Electric Circuits*, McGraw Hill
3. Charles K. Alexander & Matthew N. O. Sadiku – *Fundamentals of Electric Circuits*, McGraw Hill
4. William D. Stanley – *Network Analysis with Applications*, Pearson

25AF1000AE307A Employability and Skill Development 02 Credits

Course Objectives:

1. To develop analytical abilities.
2. To develop communication skills.
3. To introduce the students to skills necessary for getting, keeping and being successful in a profession.
4. To expose the students to leadership and team-building skills.

Course Outcomes:

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

CO1. Have skills and preparedness for aptitude tests.

CO 2. Be equipped with essential communication skills (writing, verbal and non-verbal)

CO 3. Master the presentation skill and be ready for facing interviews.

CO 4. Build team and lead it for problem solving.

Unit 1: Soft Skills & Communication basics

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.

Unit 2: Interpersonal Skills

Critical Thinking, Assertiveness, Decision Making, Problem Solving, Negotiation, Building Confidence, Time Management, Personal Presentation, Assertiveness, negotiation, avoiding Stress. Commercial Awareness: Professional etiquettes and manners.

Unit 3: Grammar and Comprehension:

English sentences and phrases, Technical writing, Paragraph writing, Story writing, Reproduction of a story, Letter writing and e-mail writing.

Unit 4: Skills for interviews:

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, tips for successful participation in group discussion, Listening skills: virtues of listening, fundamentals of good listening.

Unit 5: Problem Solving Techniques

Problem solving model: 1. Define the problem, 2. Gather information, 3. Identify various solution, 4. Evaluate alternatives, 5. Take actions, 6. Evaluate the actions. Problem solving skills: 1. Communicate. 2. Brain storming, 3. Learn from mistakes.

TEXT/REFERENCE 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. McMurrey, “A Guide to Writing as an Engineer”, ISBN: 978-1-118-30027-5 4th Edition, 2014, Wiley.

25AF1000AE307B	Innovation and Entrepreneurship	02 Credits

Course Objectives:

1. To build inspiration, aspiration, knowledge, skills, networks, practical experience, and confidence to Start-up a new Venture.

Course Outcomes:

Students will be able to:

CO1: Develop entrepreneurial mind-set and attributes;

CO2: Apply process of problem-opportunity identification and feasibility assessment through developing a macro perspective of the real market, industries, domains and customers

CO3: Analyse Customer and Market segmentation, estimate Market size.

CO4: Initiate Solution design, Prototype for Proof of Concept. Understand MVP development and validation techniques to determine Product-Market fit.

CO5: Craft initial Business and Revenue models, financial planning and pricing strategy for profitability and financial feasibility of a venture.

CO6: Understand and apply story telling skills in presenting a persuasive and defensible Venture Pitch.

Unit 1: Entrepreneurship Fundamentals & Context

Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. Gamified role play based exploration aligned to one‟s short term career aspiration and ambition. An understanding of how to build entrepreneurial mindset, skillsets, attributes and networks while on campus.

Core Teaching Tool: Simulation, Game, Industry Case Studies (Personalized for students – 16 industries to choose from), Venture Activity

Unit 2: Problem & Customer Identification

Understanding and analysing the macro Problem and Industry perspective, technological, socio-economic and urbanization trends and their implication on new opportunities. Identifying passion, identifying and defining problem using Design thinking principles.

Analysing problem and validating with the potential customer. Iterating problem-customer fit. Understanding customer segmentation, creating and validating customer personas. Competition and Industry trends mapping and assessing initial opportunity.

Core Teaching Tool: Several types of activities including: Class, game, Gen AI, „Get out of the Building‟ and Venture Activity.

Unit 3: Solution design & Prototyping

Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer‟s needs and create a strong value proposition. Developing Problem-solution fit in an iterative manner. Understanding prototyping and MVP. Developing a feasibility prototype with differentiating value, features and benefits. Initial testing for proof-of-concept and iterate on the prototype.

Core Teaching Tool: Venture Activity, nocode Innovation tools, Class activity

Unit 4: Opportunity Assessment and Sizing

Assess relative market position via competition analysis, sizing the market and assess scope and potential scale of the opportunity.

Core Teaching Tool: Class and Venture Activity

Unit 5: Business & Financial Model, Go-to-Market Plan

Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach Business planning: components of Business plan- Sales plan, People plan and financial plan, Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analysing financial performance. Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy. Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Lifecycle to Funding Options.

Core Teaching Tool: Founder Case Studies – Sama and Securely Share; Class activity and discussions; Venture Activities.

Reference Books

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition.
2. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
3. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons
4. Chowdhry Ajay, (2023) Just Aspire: Notes on Technology, Entrepreneurship and the Future.
5. Simon Sinek (2011) Start With Why, Penguin Books limited
6. Brown Tim (2019) Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business
7. Namita Thapar (2022) The Dolphin and the Shark: Stories on Entrepreneurship, Penguin Books Limited
8. Collins Jim, Porras Jerry, (2004) Built to Last: Successful Habits of Visionary Companies
9. Burlington Bo, (2016) Small Giants: Companies That Choose to Be Great Instead of Big

10. Saras D. Sarasvathy, (2008) Effectuation: Elements of Entrepreneurial Expertise, Elgar Publishing Ltd

Web Resources

Learning resource- IgniteX Course Wadhwani platform (Includes 200+ components of custom created modular content + 500+ components of the most relevant curated content)

25AF1000VE308A	Life of Ch. Shivaji Maharaj	01 Credits

Course Objectives: Completing this course the students will:

1. Analyze Chhatrapati Shivaji Maharaj's leadership qualities, strategic thinking, and management skills.
2. Develop critical thinking and problem-solving skills through case studies and discussions.
3. Recognize the relevance of the Chhatrapati's principles and values in modern times.

Course Outcomes:

CO1: Explain Chhatrapati Shivaji Maharaj's military strategies, conquests, and establishment of the Maratha Empire.

CO2: Evaluate the Chhatrapati's leadership qualities, such as courage, vision, human values and adaptability.

CO3: Apply the Chhatrapati's principles, such as decentralization and social welfare, to modern engineering challenges.

Unit 1: Shivaji Maharaj as a Great Conqueror **5 Hrs.**

- Master Strategist and innovator in Military Tactics
- Guerrilla Warfare (Ganimi Kava)
- Fortress Strategy
- Avoidance of Direct Confrontation
- Diplomacy and Alliances
- Naval Power

Unit 2: Shivaji Maharaj's Management and leadership strategies **5 Hrs.**

- Architecture and metallurgy of Raigad Fort
- Use of Light Cavalry
- Intelligence Network
- Asymmetric Warfare
- Logistics and Supply Chains
- Fortifications and Military Architecture

Unit 3 : Shivaji Maharaj's views on Democracy and Nationalism

5 Hrs.

- Shivaji Maharaj's views about Women's rights, their dignity and religious views

- His views on Democracy & Nationalism

Text Books / References:

1. Desai, Ranjit. *Shriman Yogi.* Mehta Publishing House. 2018.
2. Kurundkar, Narhar. *Chatrapati Shivaji Maharaj Jeevan Rahasya.* Deshamukh and Company. 2024.
3. Sarkar, Jadunath. Shivaji and His Times by Jadunath Sarkar, Classic Book on the Life and History of the Maratha Emperor. Nandy Books. 2024.
4. Keluskar, Krushnaji Arjun. *Chhatrapati Shivaji Maharaj*. Sudhir Prakashan. 2020.
5. Bedekar, Ninad. *Kalatil Vyavsthapan Tatve*. 2015.

25AF11461PC309L	Analog and Digital Circuits Lab	01 Credits

Analog and Digital Circuits – Laboratory Experiments

Lab 1: Diode Characteristics and Rectifiers

Study the V-I characteristics of PN junction and Zener diodes, Design and test half-wave and full-wave rectifier circuits, Implement Zener diode as a voltage regulator

Lab 2: Clipper and Clamper Circuits

Construct and analyze positive and negative clipper circuits, Design clamping circuits and observe waveform shifting, Application: simulate signal shaping used in ECG circuits

Lab 3: BJT/FET Characteristics

Plot the input and output characteristics of a BJT in CE configuration, Measure transfer and output characteristics of a JFET or MOSFET, Compare behavior under different biasing conditions

Lab 4: Single Stage Amplifier

Design and construct a BJT amplifier circuit, Measure gain, bandwidth, and frequency response Application: relate amplifier behaviour to biosignal amplification

Lab 5: Operational Amplifier Applications

Implement inverting, non-inverting, and differential amplifiers, Build integrator and differentiator circuits using op-amps,Application: create a biomedical signal filter for EMG/ECG

Digital Circuits Experiments

Lab 6: Logic Gates and Boolean Verification

Implement AND, OR, NOT, NAND, NOR, XOR, XNOR gates using ICs, Verify Boolean expressions and truth tables using logic gate combinations, Use logic trainer kits or digital simulation tools

Lab 7: Combinational Circuits

Design and test adders (half and full), subtractors, Construct multiplexer, demultiplexer, encoder, and decoder circuits, Application: data selection and display control in biomedical monitors

Lab 8: Flip-Flops and Sequential Logic

Study SR, JK, D, and T flip-flops using ICs or simulation, Analyse flip-flop timing diagrams and triggering methods, Observe basic memory element behaviour in biomedical applications

Lab 9: Counters and Shift Registers

Construct asynchronous and synchronous counters, Implement shift registers and observe data movement, Application: data sampling and timing in medical instruments

Lab 10: Mini Project or System Integration

Integrate analog and digital components to simulate a simple biomedical system, Examples: heart rate counter using op-amp amplifier and digital counter, Test system functionality with simulated biosignal input

25AF1UHVVE310	Universal Human Values II	03 Credits

Course Objectives:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Course Outcomes:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

a) Faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living.

Module 1 Introduction to Value Education

-Understanding Value Education
- Self-exploration as the Process for Value Education
- Continuous Happiness and Prosperity the Basic Human Aspirations
- Right Understanding, Relationship and Physical Facility
- Happiness and Prosperity Current Scenario
- Method to Fulfill the Basic Human Aspirations

Module 2 Harmony in the Human Being

- Understanding Human being as the Co-existence of the Self and the Body
- Distinguishing between the Needs of the Self and the Body
- The Body as an Instrument of the Self
- Understanding Harmony in the Self
- Harmony of the Self with the Body
- Programme to ensure self-regulation and Health
-

Module 3 Harmony in the Family and Society

- Harmony in the Family the Basic Unit of Human Interaction
- Values in Human-to-Human Relationship
- 'Trust' the Foundational Value in Relationship
- 'Respect' as the Right Evaluation
- Understanding Harmony in the Society
- Vision for the Universal Human Order

Module 4 Harmony in the Nature/Existence Lecture 19: Understanding Harmony in the Nature

- Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
- Realizing Existence as Co-existence at All Levels
- The Holistic Perception of Harmony in Existence

Module 5 Implications of the Holistic Understanding a Look at Professional Ethics

- Natural Acceptance of Human Values
- Definitiveness of (Ethical) Human Conduct
- A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
- Competence in Professional Ethics
- Holistic Technologies, Production Systems and Management Models-Typical Case Studies
- Strategies for Transition towards Value-based Life and Profession

1. READINGS:

Text Book and Teachers Manual

a. The Textbook

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual

Teachers‟ Manual for A Foundation Course in Human Values and Professional

Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

25AF1461CP311 Biomedical Clinical Engineering Project (CEP) 02 Credits

Course Objectives

1. To provide hands-on experience in applying biomedical engineering knowledge to solve clinical problems

2. To develop project management and teamwork skills relevant to clinical engineering

3. To foster innovation and practical understanding of biomedical devices in hospital settings

4. To encourage critical thinking, problem solving, and effective communication through project work

5. To integrate theory with practice by working on real or simulated clinical engineering projects

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Identify and define clinical engineering problems suitable for project work

CO2: Design and develop biomedical engineering solutions in collaboration with clinical settings

CO3: Apply engineering principles and standards in the development and evaluation of biomedical devices

CO4: Demonstrate effective teamwork, documentation, and presentation of project outcomes

CO5: Critically analyze project challenges and propose improvements based on feedback and testing

Unit 1: Project Identification and Planning

Selection of clinical engineering problems from hospital/clinical environments, Literature survey and feasibility analysis, Project planning, timeline, and resource allocation, Defining objectives, scope, and deliverables

Unit 2: Design and Development

System design and selection of components/materials, Prototyping biomedical devices or software solutions, Compliance with biomedical standards and safety protocols, Use of simulation and modeling tools

Unit 3: Testing and Validation

Experimental setup and data collection, Performance evaluation and troubleshooting, Safety and efficacy testing in simulated clinical conditions, Documentation of results and iterations

Unit 4: Implementation and Deployment

Integration with clinical workflows or biomedical systems, User training and demonstration

Maintenance, calibration, and technical support planning, Ethical and regulatory considerations

Unit 5: Reporting and Presentation

Preparation of project report and technical documentation, Oral presentation and demonstration to faculty and clinical experts, Peer review and feedback incorporation, Reflection on learning outcomes and future scope

Textbooks

1. Joseph J. Carr & John M. Brown – *Introduction to Biomedical Equipment Technology*, Pearson

2. Myer Kutz – *Biomedical Engineering and Design Handbook, Volumes 1 Biomedical Engineering Fundamentals* , McGraw Hill

Reference Books

1. Cromwell, L., Weibell, F., & Pfeiffer, E. – *Biomedical Instrumentation and Measurements*, Prentice Hall

2. Khandpur, R. S. – *Handbook of Biomedical Instrumentation*, Tata McGraw Hill

SEMESTER IV

25AF1461PC401	Biomedical Instrumentation	03 Credits

Course Objectives

1. To introduce principles and applications of biomedical instruments used in healthcare
2. To understand the working and design of various physiological measurement devices
3. To study different types of biosensors and transducers used in biomedical systems
4. To explore signal acquisition, conditioning, and display techniques in biomedical instrumentation
5. To familiarize students with modern diagnostic and therapeutic instruments

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Identify various biomedical instruments and understand their clinical applications
CO2: Explain the working principles of biomedical sensors and transducers
CO3: Design signal conditioning circuits for biomedical signals
CO4: Analyze the methods of acquisition and display of physiological signals
CO5: Apply knowledge of biomedical instrumentation in diagnostic and therapeutic devices

Unit 1: Introduction to Biomedical Instrumentation

Overview of biomedical instrumentation systems, Characteristics of biomedical signals, Types of biomedical instruments and measurement systems, Safety aspects and standards in biomedical instrumentation

Unit 2: Biomedical Sensors and Transducers

Types of sensors: resistive, capacitive, inductive, piezoelectric, optical, Measurement of physiological parameters: temperature, blood pressure, respiratory rate, Bioelectrical sensors: ECG, EEG, EMG electrodes and probes, Selection criteria and performance parameters of transducers

Unit 3: Signal Conditioning and Processing

Amplification, filtering, and isolation of biomedical signals, Instrumentation amplifiers and their role, Analog-to-digital conversion of biomedical signals, Noise reduction and artifact removal techniques

Unit 4: Measurement of Physiological Parameters

Cardiovascular system instrumentation: ECG, blood pressure monitors, heart rate monitors Respiratory system instrumentation: spirometers, gas analyzers, oximeters, Neurological instrumentation: EEG, nerve stimulators, Other physiological measurements: body temperature, muscle activity

Unit 5: Diagnostic and Therapeutic Instruments

Imaging systems: X-ray, ultrasound, MRI basics, Therapeutic devices: pacemakers, defibrillators, dialysis machines, Patient monitoring systems and telemetry, Emerging trends in biomedical instrumentation

Textbooks

1. John G. Webster (Ed.) – *Medical Instrumentation: Application and Design*, Wiley
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer – *Biomedical Instrumentation and Measurements*, Prentice Hall

Reference Books

1. Khandpur, R. S. – *Handbook of Biomedical Instrumentation*, Tata McGraw Hill
2. Carr, Joseph J., and Brown, John M. – *Introduction to Biomedical Equipment Technology*, Pearson

25AF1461PC402	Biomechanics	03 Credits

Course Objectives

1. To introduce the fundamental principles of mechanics as applied to biological systems
2. To understand human movement and the mechanical behavior of tissues
3. To study the mechanical properties of bones, muscles, and connective tissues
4. To apply biomechanical principles in the design of prosthetics and rehabilitation devices
5. To analyze forces and motions in the musculoskeletal system and their clinical implications

Course Outcomes (COs)

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

CO1: Apply mechanics principles to analyze biological systems and human movement
CO2: Describe mechanical properties of bones, muscles, and soft tissues
CO3: Analyze joint mechanics and musculoskeletal forces during motion
CO4: Evaluate biomechanical aspects in prosthetics, orthopedics, and rehabilitation engineering
CO5: Use biomechanical tools and methods to solve problems related to injury prevention and performance enhancement

Unit 1: Introduction to Biomechanics

Definition, scope, and applications of biomechanics, Basic concepts of mechanics: force, torque, equilibrium, stress, strain, Mechanical properties of biological tissues: elasticity, viscoelasticity, plasticity, Units and dimensions relevant to biomechanics

Unit 2: Mechanics of Biological Tissues

Structure and mechanical behavior of bone, cartilage, ligament, tendon, and muscle, Stress-strain relationships and failure criteria in tissues, Mechanical testing of tissues: tension, compression, shear, Time-dependent behavior and fatigue in biological materials

Unit 3: Kinematics and Kinetics of Human Movement

Analysis of human motion: displacement, velocity, acceleration, Types of motion: linear, angular, and general plane motion, Forces acting on the human body: ground reaction forces, muscle forces, Joint mechanics and range of motion

Unit 4: Biomechanics of Locomotion and Posture

Gait analysis and biomechanics of walking and running, Balance and stability mechanisms Biomechanics of posture and ergonomics, Injury mechanisms related to biomechanical forces

Unit 5: Applications in Prosthetics and Rehabilitation

Principles of prosthetic and orthotic design, Biomechanical considerations in implant design and joint replacements, Rehabilitation engineering and assistive devices, Recent advances and case studies in biomechanics

Textbooks

1. Margareta Nordin (Editor), Victor H. Frankel (Editor) – *Basic Biomechanics of the Musculoskeletal System*, Lippincott Williams & Wilkins
2. Donald R. Peterson, Joseph D. Bronzino – *Biomechanics: Principles and Applications*, CRC Press

Reference Books

1. Susan J. Hall – *Basic Biomechanics*, McGraw Hill
2. Y. C. Fung – *Biomechanics: Mechanical Properties of Living Tissues*, Springer-Verlag New York Inc.
3. Shrawan Kumar – *Biomechanics in Ergonomics*, CRC Press
4. David A. Winter – *Biomechanics and Motor Control of Human Movement*, Wiley

25AF1461PC403	Bio-Signal Processing	03 Credits

Course Objectives

1. To introduce the fundamental concepts of bio-signals and their characteristics
2. To study various techniques for acquisition, preprocessing, and analysis of biomedical signals
3. To understand time-domain and frequency-domain methods in signal processing
4. To learn advanced techniques like wavelet transform and adaptive filtering applied to bio-signals
5. To develop skills for practical implementation of bio-signal processing algorithms

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Identify different types of bio-signals and their characteristics

CO2: Apply preprocessing techniques to remove noise and artifacts from bio-signals

CO3: Analyze bio-signals using time-domain and frequency-domain methods

CO4: Use advanced signal processing techniques such as wavelet transform and adaptive filtering

CO5: Implement and interpret bio-signal processing algorithms for real-world biomedical applications

Unit 1: Introduction to Bio-Signals and Acquisition

Types and sources of bio-signals: ECG, EEG, EMG, and others, Characteristics of bio-signals: amplitude, frequency, and noise, Signal acquisition systems and sampling theorem Analog-to-digital conversion and quantization

Unit 2: Preprocessing of Bio-Signals

Noise and artifact sources in bio-signals, Filtering techniques: low-pass, high-pass, band-pass, and notch filters, Baseline wander removal and signal normalization, Signal enhancement and smoothing methods

Unit 3: Time-Domain and Frequency-Domain Analysis

Time-domain analysis: statistical parameters, peak detection, autocorrelation, Fourier Transform and Power Spectral Density, Short-Time Fourier Transform (STFT)
Spectral analysis of biomedical signals

Unit 4: Advanced Signal Processing Techniques

Wavelet Transform: Continuous and Discrete Wavelet Transform, Adaptive filtering techniques: LMS, RLS algorithms, Principal Component Analysis (PCA) for dimensionality reduction, Feature extraction from bio-signals

Unit 5: Applications and Implementation

ECG signal processing: QRS detection and arrhythmia classification, EEG signal processing for brain-computer interfaces, EMG signal analysis for muscle activity and prosthetic control, Use of MATLAB/Python for bio-signal processing projects

Textbooks

1. D. C. Reddy – *Biomedical Signal Processing*, Tata McGraw Hill
2. Benjamin Griffel, John L. Semmlow – *Biosignal and Medical Image Processing*, CRC Press

Reference Books

1. Rangaraj M. Rangayyan – *Biomedical Signal Analysis*, Wiley
2. Metin Akay – *Biomedical Signal Processing*, Academic Press
3. Willis J. Tompkins – *Biomedical Digital Signal Processing*, Prentice Hall

25AF1461PC404L	Bio-Signal Processing Lab	01 Credits

Labs for Bio-Signal Processing

1. **Acquisition and Visualization of Bio-Signals**
   Use data acquisition systems or simulators to record ECG, EEG, or EMG signals, Display and interpret raw bio-signals using software tools (MATLAB/Python)
2. **Signal Preprocessing and Noise Removal**
   Apply filters (low-pass, high-pass, band-pass, notch) to remove noise and artifacts from signals, Implement baseline wander removal and signal normalization techniques
3. **Time-Domain Analysis of Bio-Signals**
   Compute statistical parameters (mean, variance, RMS) of signals, Detect and analyze peaks (e.g., QRS complex in ECG), Autocorrelation and cross-correlation analysis
4. **Frequency-Domain Analysis**
   Perform Fourier Transform and Power Spectral Density estimation, Implement Short-Time Fourier Transform (STFT) for non-stationary signal analysis
5. **Advanced Signal Processing Techniques**
   Apply Wavelet Transform for feature extraction and noise reduction, Use adaptive filtering algorithms (LMS/RLS) to enhance signals, Perform Principal Component Analysis (PCA) for dimensionality reduction

Additional Activities

Mini-project: Design an algorithm for automated detection of cardiac arrhythmias from ECG signals

Comparative study of different signal processing techniques on the same bio-signal dataset

25AF1BMEOE405	Open Elective Bucket	03 Credits
25AF1BMEOE405A	Embedded System and IOT	03 Credits

Course Objectives

1. To introduce the fundamentals of embedded systems and their architecture
2. To understand programming and interfacing of microcontrollers used in biomedical applications
3. To learn the concepts and architecture of Internet of Things (IoT)
4. To study sensors, actuators, and communication protocols for IoT devices
5. To develop practical skills for designing and implementing IoT-based biomedical systems

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Describe embedded system architecture and programming for biomedical applications
CO2: Interface sensors and actuators with microcontrollers for real-time data acquisition
CO3: Understand IoT architecture, protocols, and components relevant to healthcare
CO4: Develop IoT applications using microcontrollers and wireless communication modules
CO5: Design and implement embedded IoT solutions for biomedical monitoring and control systems

Unit 1: Introduction to Embedded Systems

Overview of embedded systems: definition, characteristics, and examples, Architecture of embedded processors and microcontrollers (e.g., ARM, AVR, PIC), Embedded system hardware components: memory, I/O devices, timers, interrupts, Real-time operating systems (RTOS) basics and embedded software development

Unit 2: Microcontroller Programming and Interfacing

Microcontroller programming languages: C and assembly basics, GPIO programming, ADC, DAC interfacing, Interfacing biomedical sensors (ECG, temperature, pressure sensors), Communication interfaces: UART, SPI, I2C

Unit 3: Introduction to IoT and Architecture

IoT definition, characteristics, and applications in healthcare, IoT layered architecture: perception, network, and application layers, IoT communication protocols: MQTT, CoAP, HTTP, IoT Introduction to hardware platforms: Arduino, Raspberry Pi, ESP8266/ESP32 their features only

Unit 4: Sensors, Actuators, and Data Acquisition for IoT

Types of sensors and actuators used in biomedical IoT, Wireless communication technologies: Wi-Fi, Bluetooth, Zigbee, LoRaWAN, Data acquisition, processing, and cloud integration, Security and privacy issues in biomedical IoT systems

Unit 5: IoT Application Development and Case Studies

IoT platform setup and programming (Node-RED, ThingsBoard, Blynk), Data visualization and remote monitoring of biomedical parameters, Case studies: smart wearable devices, remote patient monitoring systems, Emerging trends: AI integration, edge computing in biomedical IoT

Textbooks

1. Raj Kamal – *Embedded Systems: Architecture, Programming and Design*, McGraw Hill
2. Arshdeep Bahga and Vijay Madisetti – *Internet of Things: A Hands-On Approach*, Orient Blackswan Private Limited - New Delhi

Reference Books

1. Peter Marwedel – *Embedded System Design*, Springer
2. Daniel Minoli – *Building the Internet of Things with IPv6 and MIPv6*, Wiley
3. Simon Monk – *Programming Arduino: Getting Started with Sketches*, McGraw Hill

25AF1BMEOE405	**Open Elective Bucket**	**03 Credits**
25AF1BMEOE405B	**Mechatronics for Medical Devices**	**03 Credits**

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Explain the fundamentals of mechatronics and its role in medical device design

CO2: Identify and use sensors and actuators in biomedical mechatronic systems

CO3: Design and analyze control systems for medical devices

CO4: Integrate mechanical, electrical, and software components to build biomedical systems

CO5: Evaluate case studies and emerging technologies in mechatronics for healthcare

Unit 1: Introduction to Mechatronics and Medical Devices

Definition and scope of mechatronics in biomedical engineering, Components of mechatronic systems: sensors, actuators, controllers, and interfaces, Overview of medical devices and their classifications, Role of mechatronics in medical instrumentation and diagnostics

Unit 2: Sensors and Actuators in Medical Devices

Types of sensors: temperature, pressure, biosensors, flow sensors, Actuators: pneumatic, hydraulic, electric motors, piezoelectric actuators, Signal conditioning and interfacing with microcontrollers

Sensor calibration and error analysis

Unit 3: Control Systems in Biomedical Mechatronics

Basics of control theory: open-loop and closed-loop systems, PID controllers and their tuning

Modeling and simulation of biomedical control systems, Examples: infusion pumps, ventilators, prosthetic limb controllers

Unit 4: Mechanical and Electrical Integration

Mechanical design considerations for medical devices, Electrical circuit design and PCB basics for biomedical systems, Microcontroller-based system integration, Power management and safety standards in medical devices

Unit 5: Applications and Emerging Trends

Mechatronic systems in imaging, rehabilitation, and surgical devices, Robotics in healthcare: surgical robots, rehabilitation robots, Wearable mechatronic devices for health monitoring

Future trends: AI integration, smart implants, and nanomechatronics

Textbooks

1. Devdas Shetty and Richard A. Kolk – *Mechatronics System Design*, Cengage Learning

2. Clarence W. de Silva – *Mechatronics: A Foundation Course*, CRC Press

Reference Books

1. David G. Alciatore and Michael B. Histand – *Introduction to Mechatronics and Measurement Systems*, McGraw Hill

2. Cromwell – *Biomedical Instrumentation and Measurements*, Prentice Hall

3. Paul H. Sydenham and Richard Thorn – *Handbook of Measuring System Design*, Wiley

4. Jacob Fraden – *Handbook of Modern Sensors: Physics, Designs, and Applications*, Springer

25AF1BMEOE405	**Open Elective Bucket**	**03 Credits**
25AF1BMEOE405C	**Fundamentals of Robotics**	**03 Credits**

Course Objectives

1. To introduce basic concepts and components of robotics relevant to biomedical applications
2. To understand robotic kinematics, dynamics, and control principles
3. To study sensors and actuators used in robotic systems
4. To learn robotic programming and automation techniques
5. To explore applications of robotics in healthcare and rehabilitation

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Understand the fundamental components and architecture of robotic systems
CO2: Analyze robot kinematics and dynamics for motion control
CO3: Apply control strategies for robotic manipulators
CO4: Interface sensors and actuators in robotic applications
CO5: Evaluate robotic applications in medical and rehabilitation engineering

Unit 1: Introduction to Robotics

Definition and classification of robots, History and evolution of robotics, Robot components: manipulators, end-effectors, sensors, actuators, controllers, Degrees of freedom and robot configurations

Unit 2: Robot Kinematics

Forward kinematics and inverse kinematics, Work space analysis, Homogeneous transformation matrices, Denavit-Hartenberg (D-H) parameters and kinematic chains

Unit 3: Robot Dynamics and Control

Dynamics of robotic manipulators, Lagrangian and Newton-Euler methods, Trajectory planning and motion control, PID and advanced control strategies

Unit 4: Sensors and Actuators in Robotics

Types of sensors: position, velocity, force, tactile, vision sensors, Actuators: DC motors, stepper motors, servomotors, pneumatic and hydraulic actuators, Sensor integration and signal processing, Feedback control systems

Unit 5: Applications of Robotics in Biomedical Engineering

Surgical robots and robotic-assisted surgery, Rehabilitation robots and prosthetics, Robot-aided diagnostics and imaging, Emerging trends: AI and machine learning in robotics, teleoperation

Textbooks

1. John J. Craig – *Introduction to Robotics: Mechanics and Control*, Pearson
2. Saeed B. Niku – *Introduction to Robotics: Analysis, Control, Applications*, Wiley

Reference Books

1. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee – *Robotics: Control, Sensing, Vision, and Intelligence*, McGraw-Hill
2. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin – *Robotic Engineering: An Integrated Approach*, Prentice Hall
3. Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel– *Industrial Robotics: Technology, Programming, and Applications*, McGraw-Hill

25AF1461MD406	**MDM Bucket**	**02 Credits**
25AF1461MD406	**Data Science and Machine Learning**	**02 Credits**

Course Objectives

1. To introduce fundamental concepts of data science and machine learning relevant to biomedical applications
2. To understand data preprocessing, visualization, and exploratory data analysis techniques
3. To learn supervised and unsupervised machine learning algorithms and their biomedical use cases
4. To develop skills to implement machine learning models using Python or relevant tools
5. To explore real-world biomedical datasets for predictive modeling and decision making

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Understand and apply data preprocessing and exploratory data analysis techniques
CO2: Implement supervised learning algorithms such as regression, decision trees, and SVM
CO3: Apply unsupervised learning methods including clustering and dimensionality reduction
CO4: Evaluate machine learning models using performance metrics and validation techniques
CO5: Analyze biomedical datasets using data science and machine learning tools for predictive insights

Unit 1: Introduction to Data Science and Data Preprocessing

Overview of data science, machine learning, and their applications in biomedical engineering, Data types, data collection, and data quality issues, Data cleaning, handling missing data, data transformation, and normalization, Exploratory Data Analysis (EDA) and visualization techniques (using Python libraries like matplotlib, seaborn)

Unit 2: Supervised Learning – Regression and Classification

Linear regression and multiple regression analysis, Logistic regression for binary classification, Decision trees and random forests, Support Vector Machines (SVM), Model training, testing, and cross-validation

Unit 3: Unsupervised Learning

Clustering techniques: K-means, hierarchical clustering, DBSCAN, Dimensionality reduction methods: PCA, t-SNE, Applications in pattern recognition and data segmentation in biomedical data

Unit 4: Model Evaluation and Optimization

Performance metrics: accuracy, precision, recall, F1-score, ROC and AUC, Overfitting and underfitting, Model tuning using grid search and hyperparameter optimization, Introduction to ensemble methods: bagging and boosting

Unit 5: Biomedical Applications and Tools

Case studies on biomedical data analysis: disease prediction, medical image analysis, Introduction to Python libraries: scikit-learn, pandas, numpy, Hands-on project: Implementing machine learning models on biomedical datasets, Ethical considerations and data privacy in biomedical data science

Textbooks

1. Aurélien Géron – *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly

2. Agrawal, Charu Gupta, Anand Sharma, Vishu Madaan, Nisheeth Joshi. – *Machine Learning and Data Science: Fundamentals and Applications*, Wiley

Reference Books

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville – *Deep Learning*, MIT Press

2. Trevor Hastie, Robert Tibshirani, Jerome Friedman – *The Elements of Statistical Learning*, Springer

3. Jason Bell – *Machine Learning: Hands-On for Developers and Technical Professionals*, Wiley

4. Sebastian Raschka – *Python Machine Learning*, Packt Publishing

25AF1COIVE407	Constitution of India	AU

Mandatory Courses (non-credit)

Universal declaration of Human Rights and Provisions of India, Constitution and Law, National Human Rights Commission and State Human Rights Commission.

Course Objectives:

1. To acquaint the students with legacies of constitutional development in India and help them to understand the most diversified legal document of India and philosophy behind it.
2. To make students aware of the theoretical and functional aspects of the Indian Parliamentary System.
3. To channelize students‟ thinking towards basic understanding of the legal concepts and its implications for engineers.
4. To acquaint students with latest intellectual property rights and innovation environment with related regulatory framework.
5. To make students learn about role of engineering in business organizations and e-governance.

Course Outcomes:

At the end of the course the students will

CO1: Identify and explore the basic features and modalities about Indian constitution.

CO2: Differentiate and relate the functioning of Indian parliamentary system at the center and state level.

CO3: Differentiate different aspects of Indian Legal System and its related bodies.

CO4: Discover and apply different laws and regulations related to engineering practices.

CO5: Correlate role of engineers with different organizations and governance models.

Constitution of India – Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the “basic structure” of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of “Constitutionalism” – a modern and progressive concept historically developed by the thinkers of “liberalism” – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The AICTE Model Curriculum for Mandatory Courses & Activities (Non-Credit) for Undergraduate Degree in Engineering & Technology 116 | Page historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of “constitutionalism” in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America. The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India‟s legacy of “diversity”. It has been said that Indian constitution reflects ideals of its freedom movement,

however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course Content :

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.

Suggested Readings:

1. Brij Kishore Sharma: Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
2. Granville Austin: The Indian Constitution: Cornerstone of a Nation. 1966, Oxford Clarendon Press.
3. Subhash C. Kashyap: Our Constitution: An Introduction to India‟s Constitution and constitutional Law, NBT, 2018.
4. PM Bakshi: The Constitution of India, Latest Edition, Universal Law Publishing.
5. V.K. Ahuja: Law Relating to Intellectual Property Rights (2007)
6. Suresh T. Viswanathan: The Indian Cyber Laws, Bharat Law House, New Delhi-88
7. P. Narayan: Intellectual Property Law, Eastern Law House, New Delhi
8. Prabudh Ganguli: Gearing up for Patents: The Indian Scenario, Orient Longman.
9. BL Wadehra: Patents, Trademarks, Designs and Geological Indications.Universal Law Publishing - LexisNexis.
10. Intellectual Property Rights: Law and Practice, Module III by ICSI (only relevant sections)
11. Executive programme study material Company Law, Module II, by ICSI (The Institute of Companies Secretaries of India) (Only relevant sections i.e., Study 1, 4

and 36). https://www.icsi.edu/media/webmodules/publications/Company%20Law.pdf
12. Handbook on e-Governance Project Lifecycle, Department of Electronics & Information Technology, Government of India, https://www.meity.gov.in/writereaddata/files/eGovernance_Project_Lifecycle_Participant_Handbook-5Day_CourseV1_20412.pdf
13. Companies Act, 2013 Key highlights and analysis by PWC. https://www.pwc.in/assets/pdfs/publications/2013/companies-act-2013-key-highlights-and-analysis.pdf

Referred Case Studies:

- Keshavanand Bharati V. State of Kerala, AIR 1973 SC 1461.
- Maneka Gandhi V. Union of India AIR, 1978 SC 597.
- S.R. Bammai V. Union of India, AIR 1994 SC 1918.
- Kuldip Nayyar V. Union of India, AIR 2006 SC312.
- A.D.M. Jabalpur V. ShivkantShakla, AIR 1976 SC1207.
- Remshwar Prasad V. Union of India, AIR 2006 SC980.
- Keshav Singh in re, AIR 1965 SC 745.
- Union of India V. Talsiram, AIR 1985 SC 1416.
- Atiabari Tea Estate Co.V. State of Assam, AIR 1961SC232.
- SBP & Co. Vs. Patel Engg. Ltd. 2005 (8) SCC 618.
- Krishna Bhagya Jala Nigam Ltd. Vs. G. Arischandra Reddy (2007) 2 SCC 720.
- Oil & Natural Gas Corporation Vs. Saw Pipes Ltd. 2003 (4) SCALE 92 – 185.

**(Other relevant case studies can be consulted by the teacher as per the topic).

Prescribed Legislations:

1. Information Technology Act, 2000 with latest amendments.
2. RTI Act 2005 with latest amendments.
3. Information Technology Rules, 2000
4. Cyber Regulation Appellate Tribunal Rules, 2000

Suggested aid for Students and Pedagogic purpose

- RSTV debates on corporate law, IPR and patent issues
- NPTEL lectures on IPR and patent rights

Episodes of 10 -part mini TV series "Samvidhan: The Making of Constitution of India" by RSTV.

25AF1000VE408B	Life of Bharat-Ratna Dr. Babasaheb Ambedkar	01 Credits

Course Objectives:

1. Analyze Dr. Ambedkar's role in shaping India's constitution and social justice movements
2. Recognize the relevance of his principles in contemporary engineering and societal contexts
3. Develop critical thinking and problem-solving skills through case studies and discussions

Course Outcomes:

CO1: Explain Dr. Ambedkar's key contributions to the Constitution of India, establishment of human values and social reform

CO2: Identify and analyze his leadership qualities and strategic thinking

CO3: Evaluate the impact of his legacy on Maharashtra's culture, politics, and economy

Unit 1: Introduction **5 Hrs.**

-Introduction to the Socio-political Context of Dr. Babasaheb Ambedkar's Era
- British Colonialism
- Indian National Movement
- Caste Hierarchy
- Untouchability
- Social Reform Movements
- Role in the Indian freedom struggle

Unit 2: The Contribution of Dr. Babasaheb Ambedkar **5 Hrs.**

- Contribution to the Constitution of India
- Vision for Social Justice and Empowerment

Unit 3: Legacy and Relevance Today **5 Hrs.**

- Dr. Ambedkar and Marxism: An Exploration of his Thoughts on Marxism
- Common Ground with Marxism
- Focus on Class Struggle
- Caste vs Caste
- Primacy of Caste in Indian Society
- Economic Ideas and Policies

Text Books / Reference:

1. Keer, Dhananjay. *Dr.Babasaheb Ambedkar Life and Mission*. Popular Prakashan. 1954.
2. Ambedkar, B. R. *Annihilation of Caste*. Fingerprint Publishing. 2023.
3. Ambedkar, B. R. *Buddha or Karl Marx*. Infinite Words. 2024.
4. Ambedkar, B. R. *The Problem of Rupee: It's Origin and it's Solution*. Sudhir Prakashan. 2021.

25AF1000HM409	Patents and IPR	02 Credits

Course objectives

1. To explore the historical development and significance of patents in fostering innovation.
2. To familiarize students with the legal frameworks governing patents.
3. To Identify and evaluate the criteria for patentability, including novelty, non-obviousness, and industrial applicability.
4. To understand the role of prior art in the patent examination process.
5. To understand the challenges and opportunities associated with filing patents globally.

Course outcomes:

Students will be able to

CO1: Demonstrate proficiency in patent categorization and practical patent procedures.

CO2: Utilize patent databases effectively.

CO3: Grasp the significance of IPR and its historical context.

CO4: Stay updated on the latest IPR developments, especially in biological systems and computer software.

CO5: Apply acquired knowledge and problem-solving skills to real-world cases related to patents and IPR.

UNIT 1: Patents

Designs, Trade and Copyright, Classification of patents in India, Categories of Patent, Special Patents, Patent document, Granting of patent, Rights of a patent, Patent Searching, Patent Drafting, filing of a patent, different layers of the international patent system, Utility models.

UNIT 2: Patent Rights

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT 3: Overview of Intellectual Property

Introduction of IPR, Need for intellectual property right (IPR), IPR in India – Genesis and Development IPR in abroad.

UNIT 4: New Developments in IPR

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge, Case Studies.

UNIT 5: Case studies:

Case studies related to patents and IPR

TEXT/REFERENCE BOOKS:

1. Feroz Ali, The Law of Patents, LexisNexis
2. Ronald D. Slusky, Invention Analysis and Claiming – A Patent Lawyer‟s Guide, Second Edition, American Bar Association, 2012.
3. Feroz Ali, The Touchstone Effect – The Impact of Pre-grant Opposition on Patents, LexisNexis, 2009.

25AF1000AE410A	Marathi	02 Credits

उपयोजित मराठी/ व्यावहारिक मराठी अभ्यासक्रम

Course Code	Course Title	Teaching Scheme			Examination Scheme					
		L	T	P	Continuous Assessment (1)	Continuous Assessment (2)	Mid Term Test	End Semester Exam	Total	Credits
2311372AE204 24UD1000AE410A	उपयोजित मराठी/ व्यावहारिक मराठी	2	0	0	10	10	20	60	100	2

Course Objectives:

- मराठी भाषेचा ऐतिहासिक प्रवास, तिच्या निर्मितीतील संस्कृत, प्राकृत आणि अपभ्रंश भाषांचा प्रभाव समजून घेणे.
- मराठी लेखनाचे नियम, व्याकरण व शुद्धलेखन यांची अचूकता आत्मसात करणे.
- सर्जनशील आणि औपचारिक लेखन कौशल्ये विकसित करणे.
- भाषांतर तत्त्वे, प्रक्रिया आणि सांस्कृतिक संदर्भ यांचा विचार करून मराठीतून इंग्रजी आणि इंग्रजीतून मराठी भाषांतर करण्याचे कौशल्य प्राप्त करणे.

Course Outcomes:

- विद्यार्थी मराठी भाषेच्या ऐतिहासिक प्रवासाची समज वाढवतील आणि तिच्या विकासातील टप्पे स्पष्टपणे सांगू शकतील.
- शुद्ध व प्रमाणबद्ध लेखन करण्याची क्षमता प्राप्त होईल.
- विविध प्रकारच्या लेखन शैली आत्मसात करून सृजनशील, विश्लेषणात्मक आणि औपचारिक लेखन करू शकतील.
- अचूक, स्पष्ट आणि भाषिक-सांस्कृतिक दृष्टिकोनातून योग्य भाषांतर करू शकतील.
- व्यावसायिक आणि साहित्यिक भाषांतरात प्रावीण्य मिळवू शकतील.

घटक- १. मराठीचा उगम आणि विकास

- मराठीचा उगम आणि विकास
- मराठी भाषेवर संत परंपरेचा प्रभाव- ज्ञानेश्वर, तुकाराम, नामदेव आणि एकनाथ यांच्या रचनांचा अभ्यास.
- मराठीत बखरी लेखन व इतिहासदर्शन.
- आधुनिक मराठी आणि सुधारणा चळवळी- टिळक, फुले, आणि आगरकर यांचे योगदान.

घटक- २. स्वातंत्र्यानंतरची मराठी भाषा

- महाराष्ट्र राज्य निर्मिती व मराठीचा अधिकृत दर्जा.
- डिजिटल युगातील मराठी भाषा : ब्लॉग, सोशल मीडिया आणि ई-साहित्य.
- मराठी भाषा संरक्षणासाठी उपाययोजना.
- शिक्षणव्यवस्थेतील मराठीचा वापर.
- जागतिक स्तरावर मराठी भाषेचा प्रभाव.

घटक-३. मराठी लेखनाचे नियम आणि व्याकरण

- संधि
- वाक्यप्रकार (विधानार्थी वाक्य, प्रश्नार्थी वाक्य, आज्ञार्थी वाक्य इ.)
- विरामचिन्हे आणि त्यांचे उपयोग
- शुद्धलेखन
- समानार्थी शब्द (पर्यायवाची शब्द), विरुद्धार्थी शब्द

घटक-४. लेखन कौशल्य

- लेखन कौशल्याचा परिचय- लेखन कौशल्याचे महत्त्व आणि आवश्यकता
- पत्रलेखन
- निबंध लेखन
- वृत्तलेखन (वृत्तपत्रीय लेखन)
- इतिवृत्त लेखन
- सारांश लेखन

घटक- ५. भाषांतर (मराठीतून इंग्रजी अणि इंग्रजीतून मराठी)

- भाषांतराचा मूलभूत परिचय- भाषांतराची व्याख्या आणि स्वरूप, महत्त्व आणि उपयोग, भाषांतराचे प्रकार इ.
- पारिभाषिक शब्दावली

- मराठीतून इंग्रजी आणि इंग्रजीतून मराठी भाषांतर.

संदर्भ साहित्य

1. प्रशासनिक लेखन, भाषा संचालनालय , महाराष्ट्र शासन, मुंबई १९६६
2. सुगम मराठी व्याकरण व लेखन - मो.रा. वाळंबे
3. "अनुवाद सिद्धांत आणि प्रयोग" – डॉ. भालचंद्र नेमाडे (लोकवाङ्मय गृह प्रकाशन)
4. मराठी भाषा आणि साहित्याचा इतिहास – वि.का. राजवाडे प्रकाशक : राजवाडे संशोधन मंडळ, धुळे
5. भाषांतर : सिद्धांत आणि प्रयोग – डॉ. अशोक केळकर प्रकाशक : लोकवाङ्मय गृह, मुंबई

25AF1000AE410B	Hindi	02 Credits

सामान्य हिंदी / व्यावहारिक हिंदी पाठ्यक्रम

पाठ्यक्रम उद्देश्य (Course Objectives):

- हिंदी भाषा के उद्भव, विकास और ऐतिहासिक प्रवृत्तियों को समझाना।
- हिंदी व्याकरण और लेखन कौशल में दक्षता प्रदान करना।
- प्रशासन, शिक्षा और संचार में हिंदी के व्यावहारिक उपयोग को स्पष्ट करना।
- अनुवाद कौशल विकसित करना, जिससे तकनीकी एवं व्यावसायिक संचार सुगम हो।

अपेक्षित परिणाम (Course Outcomes):

- विद्यार्थी हिंदी भाषा के ऐतिहासिक और आधुनिक विकास को समझेंगे।
- हिंदी व्याकरण और लेखन के नियमों में दक्षता प्राप्त करेंगे।
- व्यावसायिक, प्रशासनिक और तकनीकी लेखन में हिंदी का प्रयोग कर सकेंगे।
- अनुवाद के सिद्धांतों को सीखकर अंग्रेजी और हिंदी के बीच प्रभावी अनुवाद कर सकेंगे।

इकाई – १. हिंदी भाषा का उद्भव और स्रोत

- हिंदी भाषा की उत्पत्ति और स्वरूप
- संस्कृत, प्राकृत और अपभ्रंश से हिंदी का विकास
- हिंदी की प्रमुख बोलियाँ (ब्रज, अवधी, खड़ी बोली, भोजपुरी, राजस्थानी आदि)
- हिंदी पर फारसी, अरबी और अंग्रेज़ी भाषाओं का प्रभाव

इकाई- २. स्वातंत्र्योत्तर काल में हिंदी भाषा

- प्रशासन, शिक्षा और संचार माध्यमों में हिंदी की भूमिका
- राजभाषा के रूप में हिंदी – संवैधानिक स्थिति और व्यावहारिक उपयोग
- हिंदी का वैश्विक विस्तार और डिजिटल माध्यमों में हिंदी की उपस्थिति
- प्रशासन और संचार माध्यमों में हिंदी

इकाई- ३. हिंदी भाषा लेखन के नियम और व्याकरण

- वर्णमाला
- शब्द-भेद
- संधि
- वाक्य रचना
- वर्तनी
- उपसर्ग, प्रत्यय और शब्द निर्माण की प्रक्रिया
- विराम चिन्हों का प्रयोग
- पर्यायवाची शब्द
- विलोम शब्द

इकाई- ४. लेखन कौशल

- पत्र लेखन
- प्रतिवेदन (रिपोर्ट) लेखन
- विज्ञप्ति, नोटिस और परिपत्र लेखन

- निबंध लेखन
- सार लेखन

इकाई- ५. अनुवाद (अंग्रेजी से हिंदी और हिंदी से अंग्रेजी)

- अनुवाद : सिद्धांत और परंपरा
- अनुवाद : क्षेत्र, प्रकार
- पारिभाषिक शब्दावली
- अंग्रेजी से हिंदी और हिंदी से अंग्रेजी अनुवाद

संदर्भ ग्रंथ:

- "हिंदी भाषा का उद्भव और विकास" – डॉ. हरीशचंद्र वर्मा (लोकभारती प्रकाशन)
- "हिंदी भाषा का इतिहास" – डॉ. रामकिशोर शर्मा (राजकमल प्रकाशन)
- "भारत में राजभाषा हिंदी" – डॉ. विश्वनाथ प्रसाद (भारतीय राजभाषा परिषद)
- "हिंदी व्याकरण और रचना" – डॉ. हरीशचंद्र वर्मा (लोकभारती प्रकाशन)
- "हिंदी लेखन कौशल" – डॉ. रमेश गुप्त (साहित्य भवन)
- "अनुवाद विज्ञान और सिद्धांत" – डॉ. ओमप्रकाश (राजकमल प्रकाशन)

25AF1000AE410C	Sanskrit	02 Credits

संस्कृत अभ्यासक्रम

Course Objectives:

- संस्कृत भाषेचा ऐतिहासिक प्रवास
- संस्कृत लेखनाचे नियम, व्याकरण आत्मसात करणे.
- दैनंदिन संवादासाठी लागणारे काही शब्द यांचा अभ्यास करणे.

Course Outcomes:

- विद्यार्थी संस्कृत भाषेच्या ऐतिहासिक प्रवासाशी समन्वय साधतील आणि तिच्या विकासातील टप्पे स्पष्टपणे सांगू शकतील.
- शुद्ध व प्रमाणबद्ध लेखन करण्याची क्षमता प्राप्त होईल.
- विविध प्रकारच्या लेखन शैली आत्मसात करून लेखन करू शकतील.
- अचूक, स्पष्ट आणि भाषिक-सांस्कृतिक दृष्टिकोनातून योग्य भाषांतर करू शकतील.

1. Introduction to Sanskrit

- Importance and history of Sanskrit
- Sanskrit alphabets (Varnamala)
- Swaras (Vowels)
- Vyanjanas (Consonants)
- Pronunciation and script (Devanagari)

2. Basic Grammar

- Nouns, pronouns, Grammatical numbers, Grammatical genders, Grammatical person

- Verbs, Tenses, Sandhi (Combination of letters)
- Karaka (Case system) – Nominative, Accusative, Instrumental, etc.
- Vibhakti (Declensions of nouns and pronouns)
- Linga (Gender: Masculine, Feminine, Neuter)
- Vakya Rachana (Sentence construction)

3. Simple Vocabulary and Sentence Formation
- Basic words and their meanings (nature, family, animals, objects, etc.)
- Greetings and basic conversational phrases
- Formation of simple sentences

4. Selected Sanskrit Shlokas and Subhashitas
- Recitation and meaning of simple verses from Bhagavad Gita, Hitopadesha, or Panchatantra
- Common proverbs (Subhashitas)

5. Reading and Writing Practice
- Reading simple Sanskrit texts
- Writing small paragraphs in Sanskrit

25AF1461VS411	Biomedical Prototype Designing	02 Credits

Course Objectives

1. To introduce the concepts and stages of biomedical prototype design
2. To develop skills in using tools and techniques for designing biomedical devices
3. To understand the integration of mechanical, electrical, and software components in prototype development
4. To emphasize iterative design, testing, and improvement processes
5. To foster creativity and innovation for biomedical solutions

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Explain the biomedical prototype design process from concept to implementation
CO2: Apply design thinking and CAD tools for biomedical device prototyping
CO3: Integrate hardware and software components for biomedical prototypes
CO4: Test, evaluate, and improve biomedical prototypes based on feedback
CO5: Document and present biomedical prototype designs effectively

Unit 1: Introduction to Biomedical Prototype Designing

Overview of prototyping in biomedical engineering, Stages of prototype design: concept, design, fabrication, testing, Design thinking and user-centered design principles, Case studies of successful biomedical prototypes

Unit 2: Tools and Techniques for Prototyping

Computer-Aided Design (CAD) tools (e.g., SolidWorks, AutoCAD), Rapid prototyping techniques: 3D printing, CNC machining, Basics of electronics prototyping: breadboards, microcontrollers, Software tools for embedded systems and simulations

Unit 3: Mechanical and Electrical Integration

Mechanical design considerations for biomedical devices, Sensor and actuator selection and interfacing, Microcontroller programming basics for prototype control, Power supply and safety considerations

Unit 4: Testing and Validation

Prototype testing methodologies, Performance evaluation and troubleshooting, Iterative design and improvement processes, Regulatory and ethical considerations in prototype development

Unit 5: Documentation and Presentation

Preparing design documentation and reports, Technical drawing and specifications, Presentation skills for biomedical prototypes, Intellectual property and patent basics

Textbooks

1. Kevin Otto and Kristin Wood – *Product Design: Techniques in Reverse Engineering and New Product Development*, Pearson
2. Cromwell – *Biomedical Instrumentation and Measurements*, Prentice Hall

Reference Books

1. Chan, Anthony Y. K.– *Biomedical Device Technology: Principles and Design*, Charles C Thomas Pub Ltd
2. Tugrul Özel et.al.– *Biomedical Devices: Design, Prototyping, and Manufacturing*, Wiley
3. Donald R. Askeland – *The Science and Engineering of Materials*, Cengage Learning

25AF1461PC412L	Biomedical Instrumentation Lab	01 Credits

Labs for Biomedical Instrumentation

1. **Study of Biomedical Signal Characteristics and Measurement**

   Measurement and analysis of bioelectric signals (ECG, EMG, EEG) using standard electrodes and equipment, Observation of amplitude, frequency, and noise in biomedical signals

2. **Study and Calibration of Biomedical Sensors and Transducers**

   Calibration and characterization of temperature sensors, pressure sensors, and photoplethysmographic (PPG) sensors, Measurement of blood pressure using a digital and manual sphygmomanometer setup

3. **Signal Conditioning Circuits**

   Design and testing of instrumentation amplifiers for weak biomedical signals, Implementation of filters (low pass, high pass) to remove noise and artifacts from signals, Isolation amplifier demonstrations for patient safety

4. **Measurement of Physiological Parameters**

Recording and analysis of ECG signals with data acquisition systems, Measurement of respiratory rate using spirometer or breath sensors, Pulse oximetry: working and data analysis from pulse oximeter sensor

5. **Study of Diagnostic and Therapeutic Devices**

Demonstration and operation of medical imaging modalities (video or simulation): X-ray, ultrasound basics, Functionality test of pacemaker or defibrillator simulators, Patient monitoring system setup and real-time data acquisition

Additional Lab Activities

Use of software tools for biomedical signal processing (e.g., MATLAB/Simulink)
Simulation of bio-signal acquisition and processing using virtual instruments
Mini-project: Design a simple heart rate monitoring system using sensors and microcontrollers

25AF1461PC413L	Biomechanics Lab	01 Credits

Labs for Biomechanics

1. **Mechanical Properties of Biological Materials**

   Perform tensile and compression tests on synthetic materials mimicking bone or soft tissue, Analyze stress-strain curves and calculate elastic modulus and yield strength

2. **Measurement of Joint Range of Motion (ROM)**

   Use goniometers to measure ROM of major joints (knee, elbow, shoulder), Analyze differences in ROM across individuals or under different conditions

3. **Gait Analysis and Human Locomotion**

   Record walking/running patterns using video capture or motion sensors,Analyze gait parameters such as stride length, cadence, and ground reaction forces

4. **Muscle Force Estimation and EMG Studies**

   Use electromyography (EMG) to measure muscle activity during different movements, Correlate EMG signals with muscle force generation and joint movement

5. **Ergonomics and Posture Analysis**

   Evaluate workplace ergonomics by analyzing posture and forces exerted during tasks, Propose ergonomic improvements based on biomechanical principles

Additional Activities

Use software tools (e.g., OpenSim, MATLAB) for biomechanical modeling and simulation
Mini-project: Design and test a simple prosthetic or orthotic device component