VIVEKANANDHA

COLLEGE OF ENGINEERING FOR WOMEN

(An Autonomous Institution Affiliated to Anna University - Chennai

Approved by AICTE - Accredited by NBA New Delhi)

Elayampalayam, Tiruchengode – 637 205, Namakkal District, Tamilnadu.

B.E. BIOMEDICAL ENGINEERING

CURRICULA & SYLLABI

REGULATION 2019

CHOICE BASED CREDIT SYSTEM

[CBCS]

Signature of BOS Chairman BME

VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
(Autonomous Institution, Affiliated to Anna University, Chennai)
Elayampalayam, Tiruchengode – 637 205

COLLEGE VISION

To impart value based education in Engineering and Technology to empower young women to meet the societal exigency with a global outlook.

COLLEGE MISSION

- To provide holistic education through innovative teaching-learning practices
- To instill self confidence among rural students by supplementing with co-curricular and extra-curricular activities
- To inculcate the spirit of innovation through training, research and development
- To provide industrial exposure to meet the global challenges
- To create an environment for continual progress through lifelong learning

DEPARTMENT VISION

To delegate a high-grade woman Biomedical Engineer for contemporary and ethical research for the society in the health care field and to furnish industry oriented enlightenment.

DEPARTMENT MISSION

Department of BME is committed to

- Create a new Technology in the healthcare field, provide to study human anatomy and physiology along with the engineering principles.
- Satisfy the industrial need, necessary trainings provide for the future Biomedical Engineers.
- Impart and improve self-educated skills and entrepreneurship qualities.

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B.E. BIOMEDICAL ENGINEERING
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PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

Graduates of Biomedical Engineering will

PEO 1. Demonstrate their skills in solving challenges in their chosen field through the core foundation and knowledge acquired in engineering and biology.

PEO 2. Exhibit leadership, make decisions with societal and ethical responsibilities, function and communicate effectively in multidisciplinary settings.

PEO 3. Recognize the need for sustaining and expanding their technical competence and engage in learning opportunities throughout their careers.

PROGRAM OUTCOMES (POs):

PO 1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. **Design/Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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PO 6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

At the end of this program, graduate will be able to:

PSO1. Design and develop diagnostic and therapeutic devices those reduces physician burnout and enhance the quality of life for the end user by applying fundamentals of Biomedical Engineering.

PSO2. To apply software skills in developing algorithms for solving healthcare related problems in various fields of Medical sector.

PSO3. To adapt to emerging information and communication technologies (ICT) to innovate ideas and solutions for current societal and scientific issues thereby developing indigenous medical instruments that are on par with the existing technology.

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MAPPING OF PROGRAM EDUCATIONAL OBJECTIVES WITH PROGRAM OUTCOMES:

PROGRAM EDUCATIONAL OBJECTIVES	PROGRAM OUTCOMES											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
PEO 1	✓	✓	✓	✓	✓	✓	✓	✓				
PEO 2				✓		✓	✓	✓	✓	✓	✓	
PEO 3	✓	✓	✓	✓	✓				✓	✓	✓	✓

Sem	Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
I	Calculus	✓	✓	✓			✓						✓
	English for Communication- I						✓	✓	✓	✓	✓	✓	✓
	Engineering Chemistry	✓	✓	✓			✓						✓
	Programming for Problem Solving	✓	✓	✓			✓						✓
	Engineering Graphics	✓	✓	✓			✓						
	Mandatory Course-II												
	Chemistry Laboratory	✓	✓			✓			✓	✓	✓		
	Computer Practices Laboratory	✓	✓			✓			✓	✓	✓		
II	Linear Algebra and Ordinary Differential Equations	✓	✓	✓			✓						✓
	English for Communication- II						✓	✓	✓	✓	✓	✓	✓
	Engineering Physics	✓	✓	✓			✓						✓
	Basic Civil and Mechanical Engineering	✓	✓	✓				✓	✓				✓
	Basic Electrical and Electronics Engineering	✓	✓	✓			✓						✓
	Electric Circuit Theory	✓	✓	✓			✓						
	Mandatory Course-I												
	Physics Laboratory	✓	✓			✓			✓	✓	✓	✓	✓
	Engineering Practices Laboratory	✓	✓			✓			✓	✓	✓	✓	✓
III	Transforms and Partial differential Equations	✓	✓	✓								✓	✓

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	Anatomy and Human Physiology	✓	✓				✓		✓	✓		✓	✓
	Bio Sensors and Measurement Devices	✓	✓	✓	✓	✓	✓						
	Fundamentals of Bio Chemistry	✓	✓										
	Digital System Design	✓	✓	✓			✓						✓
	Electron Devices and Circuits	✓	✓							✓			✓
	Mandatory Course-III												
	Bio Chemistry and Human Physiology Laboratory	✓	✓	✓	✓	✓				✓			
	Bio Sensors and Measurements Laboratory	✓	✓			✓				✓	✓	✓	
	Electron Devices and Circuits Laboratory	✓	✓			✓				✓	✓	✓	
IV	Probability and Statistics	✓	✓	✓								✓	✓
	Medical Physics	✓	✓	✓	✓		✓		✓	✓		✓	✓
	Signals and Systems	✓	✓	✓			✓						
	Data Structures	✓	✓	✓									✓
	Linear Integrated Circuits	✓	✓	✓			✓						✓
	Pathology and Microbiology	✓	✓	✓	✓		✓		✓	✓		✓	✓
	Mandatory Course-IV												
	Analog and Linear Integrated Circuits Laboratory	✓	✓			✓			✓	✓	✓	✓	✓
	Pathology and Microbiology Laboratory	✓	✓	✓		✓			✓	✓	✓		✓
V	Bio Control Systems	✓	✓	✓	✓		✓		✓			✓	✓
	Digital Signal Processing	✓	✓	✓			✓						✓
	Analog and Digital Communication	✓	✓	✓			✓						✓
	Biomedical Instrumentation	✓	✓	✓		✓	✓		✓				
	Professional Elective -I												
	Open Elective –I												

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	Mandatory Course-V												
	Digital Signal Processing Laboratory	✓	✓			✓			✓	✓	✓	✓	✓
	Biomedical Instrumentation Laboratory	✓	✓	✓		✓			✓				
	Communication Skills Laboratory						✓	✓	✓	✓	✓		✓
VI	Medical Image Processing	✓	✓	✓			✓						✓
	Diagnostic and Therapeutic Equipment – I		✓	✓		✓	✓						✓
	Microprocessor and Microcontroller	✓	✓	✓			✓					✓	✓
	Professional Elective-II												
	Open Elective-II												
	Mandatory Course-VI												
	Medical Image Processing Laboratory	✓	✓			✓			✓	✓	✓	✓	✓
	Microprocessor and Microcontroller Laboratory	✓	✓			✓			✓	✓	✓	✓	✓
	Mini Project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VII	Diagnostic and Therapeutic Equipment – II		✓	✓		✓	✓						✓
	Radiological Equipments	✓	✓	✓						✓	✓	✓	
	Professional Elective-III												
	Professional Elective-IV												
	Open Elective-III												
	Diagnostic and Therapeutic Equipment Laboratory	✓	✓	✓	✓	✓		✓	✓				✓
	Hospital Training	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VIII	Professional Elective – V												
	Professional Elective – VI												
	Project Work	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**I**

CURRICULUM

(Applicable to the students admitted from the academic year 2019 – 2020 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19MA101	Calculus *	BSC	3	1	0	4	50	50	100
U19EN101	English For Communication- I *	HSC	3	0	0	3	50	50	100
U19CH105	Engineering Chemistry@	BSC	3	0	0	3	50	50	100
U19CS101	Programming for Problem Solving*	ESC	3	0	0	3	50	50	100
U19GE101	Engineering Graphics*	ESC	2	0	3	3	50	50	100
PRACTICAL									
U19CH106	Chemistry Laboratory @	BSC	0	0	4	2	50	50	100
U19CS102	Computer Practices Laboratory*	ESC	0	0	4	2	50	50	100
MANDATORY COURSE									
U19MCFY2	Indian Constitution and Universal Human Values	MC	3	0	0	0	100	--	100
Total Credits						**20**	**450**	**350**	**800**

BSC - Basic Science Courses, ESC - Engineering Science Courses, MC-Mandatory courses, HSC - Humanities and Social Sciences Courses, CA- Continuous Assessment, ESE - End Semester Examination.

* Common for all branches

@ Common for ECE, EEE, BME

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**II**

CURRICULUM

(Applicable to the students admitted from the academic year 2019 – 2020 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19MA202	Linear Algebra and Ordinary Differential Equations *	BSC	3	1	0	4	50	50	100
U19EN202	English For Communication- II *	HSC	3	0	0	3	50	50	100
U19PH207	Engineering Physics $	BSC	3	0	0	3	50	50	100
U19EE201	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	50	50	100
U19GE202	Basic Civil and Mechanical Engineering *	ESC	3	0	0	3	50	50	100
U19EC201	Electric Circuit Theory	PCC	3	0	0	3	50	50	100
PRACTICAL									
U19PH208	Physics Laboratory$	BSC	0	0	4	2	50	50	100
U19GE203	Engineering Practices Laboratory *	ESC	0	0	4	2	50	50	100
MANDATORY COURSE									
U19MCFY1	Environmental Science and Engineering	MC	3	0	0	0	100	--	100
					Total Credit	**23**	**500**	**400**	**900**

BSC - Basic Science Courses, ESC - Engineering Science Courses, PCC - Professional core courses, MC- Mandatory courses, HSC - Humanities and Social Sciences Courses, CA- Continuous Assessment, ESE - End Semester Examination.

* Common for all branches

$ Common for ECE, EEE, BME

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Programme	**B.E.**	Programme Code	**106**		Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**				Semester	**III**			
CURRICULUM (Applicable to the students admitted from the academic year 2019-2020 onwards)									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19MA303	Transforms and Partial differential Equations*	BSC	3	1	0	4	50	50	100
U19BM301	Anatomy and Human Physiology	PCC	3	0	0	3	50	50	100
U19BM302	Bio Sensors and Measurement Devices	PCC	3	0	0	3	50	50	100
U19BM303	Fundamentals of Bio Chemistry	PCC	3	0	0	3	50	50	100
U19EC315	Digital System Design	PCC	3	0	0	3	50	50	100
U19EC316	Electron Devices and Circuits	PCC	3	0	0	3	50	50	100
PRACTICAL									
U19BM304	Bio Sensors and Measurements Laboratory	PCC	0	0	2	1	50	50	100
U19BM305	Bio Chemistry and Human Physiology Laboratory	PCC	0	0	2	1	50	50	100
U19EC317	Electron Devices and Circuits Laboratory	PCC	0	0	2	1	50	50	100
MANDATORY COURSE									
U19MCSY3	Numerical Ability	MC	3	0	0	0	100	--	100
					Total Credits	**22**	**550**	**450**	**1000**

BSC - Basic Science Courses, PCC – Professional Core Courses, MC- Mandatory courses, CA - Continuous Assessment, ESE - End Semester Examination

* Common for all branches

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205								
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**				
Department	**BIOMEDICAL ENGINEERING**			Semester	**IV**				
CURRICULUM (Applicable to the students admitted from the academic year 2019-2020 onwards)									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19MA408	Probability and Statistics*	BSC	3	1	0	4	50	50	100
U19BM406	Medical Physics	PCC	3	0	0	3	50	50	100
U19CS417	Data Structures	ESC	3	0	0	3	50	50	100
U19EC419	Signals and Systems	PCC	3	0	0	3	50	50	100
U19EC420	Linear Integrated Circuits	PCC	3	0	0	3	50	50	100
U19BM407	Pathology and Microbiology	PCC	3	0	0	3	50	50	100
PRACTICAL									
U19EC421	Analog and Linear Integrated Circuits Laboratory	PCC	0	0	2	1	50	50	100
U19BM408	Pathology and Microbiology Laboratory	PCC	0	0	2	1	50	50	100
U19CS418	Data Structures Laboratory	ESC	0	0	4	2	50	50	100
MANDATORY COURSE									
U19MCSY4	Verbal Ability	MC	3	0	0	0	100	--	100
					Total Credits	**23**	**550**	**450**	**1000**

BSC - Basic Science Courses, PCC – Professional Core Courses , EEC - Employability Enhancement Courses, MC- Mandatory courses, CA - Continuous Assessment, ESE - End Semester Examination

* Common Syllabus for ECE, EEE & BT

Signature of BOS Chairman BME

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**				
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**				
CURRICULUM (Applicable to the students admitted from the academic year 2019-2020 onwards)									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19BM509	Bio Control Systems	PCC	3	0	0	3	50	50	100
U19EC411	Digital Signal Processing*	PCC	3	1	0	4	50	50	100
U19EC521	Analog and Digital Communication*	PCC	3	0	0	3	50	50	100
U19BM510	Biomedical Instrumentation	PCC	3	0	0	3	50	50	100
	Professional Elective –I	PEC	3	0	0	3	50	50	100
	Open Elective –I	OEC	3	0	0	3	50	50	100
PRACTICAL									
U19EC416	Digital Signal Processing Laboratory*	PCC	0	0	2	1	50	50	100
U19BM511	Biomedical Instrumentation Laboratory	PCC	0	0	2	1	50	50	100
U19EN503	Communication Skills Laboratory*	HSC	0	0	2	1	100	--	100
MANDATORY COURSE									
U19MCTY5	Logical Reasoning	MC	3	0	0	0	100	--	100
					Total Credits	**22**	**600**	**400**	**1000**

PCC – Professional Core Courses , HSC - Humanities and Social Science Courses, PEC - Professional Elective Courses, OEC-Open Elective Courses, MC- Mandatory courses, CA - Continuous Assessment, ESE - End Semester Examination

* Common Syllabus for ECE.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**

CURRICULUM

(Applicable to the students admitted from the academic year 2019-2020 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19EC519	Microprocessor and Microcontroller *	PCC	3	0	0	3	50	50	100
U19BM612	Medical Image Processing	PCC	3	0	0	3	50	50	100
U19BM613	Diagnostic and Therapeutic Equipment - I	PCC	3	0	0	3	50	50	100
	Professional Elective-II	PEC	3	0	0	3	50	50	100
	Open Elective-II	OEC	3	0	0	3	50	50	100
PRACTICAL									
U19BM614	Medical Image Processing Laboratory	PCC	0	0	2	2	50	50	100
U19EC522	Microprocessor and Microcontroller Laboratory*	PCC	0	0	2	1	50	50	100
U19BM615	Mini Project	EEC	0	0	4	3	50	50	100
MANDATORY COURSE									
U19MCTY6	Personality Development	MC	3	0	0	0	100	--	100
					Total Credits	**21**	**500**	**400**	**900**

PCC – Professional Core Courses , PEC - Professional Elective Courses , EEC - Employability Enhancement Courses, OEC-Open Elective Courses, MC- Mandatory courses, CA - Continuous Assessment, ESE - End Semester Examination

*
Common Syllabus for ECE.

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**VII**

CURRICULUM

(Applicable to the students admitted from the academic year 2019-2020 onwards)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
U19BM716	Diagnostic and Therapeutic Equipment – II	PCC	3	0	0	3	50	50	100
U19BM717	Radiological Equipments	PCC	3	0	0	3	50	50	100
	Professional Elective-III	PEC	3	0	0	3	50	50	100
	Professional Elective-IV	PEC	3	0	0	3	50	50	100
	Open Elective-III	OEC	3	0	0	3	50	50	100
PRACTICAL									
U19BM718	Diagnostic and Therapeutic Equipment Laboratory	PCC	0	0	2	2	50	50	100
U19BM719	Hospital Training	EEC	0	0	4	3	100	-	100
					Total Credits	**20**	**400**	**300**	**700**

PCC – Professional Core Courses, PEC - Professional Elective Courses , EEC - Employability Enhancement Courses, OEC - Open Elective Courses, MC- Mandatory courses, CA - Continuous Assessment, ESE - End Semester Examination

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205								
Programme	**B.E.**		Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**				Semester	**VIII**			
CURRICULUM (Applicable to the students admitted from the academic year 2019-2020 onwards)									
Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
THEORY									
	Professional Elective – V	PEC	3	0	0	3	50	50	100
	Professional Elective – VI	PEC	3	0	0	3	50	50	100
PRACTICAL									
U19BM720	Project Work	EEC	0	0	16	8	50	50	100
					Total Credits	**14**	**150**	**150**	**300**

PEC - Professional Elective Courses, EEC - Employability Enhancement Courses, MC- Mandatory courses, CA - Continuous Assessment, ESE - End Semester Examination

Cumulative Course Credit: **165**

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HUMANITIES AND SOCIAL SCIENCE COURSES (HSC)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
U19EN101	English for Communication- I	HSC	3	0	0	3	50	50	100
U19EN202	English for Communication- II	HSC	3	0	0	3	50	50	100
U19EN503	Communication Skills Laboratory	HSC	0	0	2	1	100	--	100

BASIC SCIENCE COURSES (BSC)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
U19MA101	Calculus	BSC	3	1	0	4	50	50	100
U19CH105	Engineering Chemistry	BSC	3	0	0	3	50	50	100
U19CH106	Chemistry Laboratory	BSC	0	0	4	2	50	50	100
U19MA202	Linear Algebra and Ordinary Differential Equations	BSC	3	1	0	4	50	50	100
U19PH207	Engineering Physics	BSC	3	0	0	3	50	50	100
U19PH208	Physics Laboratory	BSC	0	0	4	2	50	50	100
U19MA303	Transforms and Partial differential Equations	BSC	3	1	0	4	50	50	100
U19MA408	Probability and Statistics	BSC	3	1	0	4	50	50	100

ENGINEERING SCIENCE COURSES (ESC)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
U19CS101	Programming for Problem Solving	ESC	3	0	0	3	50	50	100
U19GE101	Engineering Graphics	ESC	3	0	0	3	50	50	100
U19CS102	Computer Practices Laboratory	ESC	0	0	4	2	50	50	100
U19GE202	Basic Civil and Mechanical Engineering	ESC	3	0	0	3	50	50	100
U19EE201	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	50	50	100

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U19GE203	Engineering Practices Laboratory	ESC	0	0	4	2	50	50	100
U19CS417	Data Structures	ESC	3	0	0	3	50	50	100
U19CS418	Data Structures Laboratory	ESC	0	0	4	2	50	50	100

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
U19BM615	Mini Project	EEC	0	0	4	2	100	-	100
U19BM719	Hospital Training	EEC	0	0	4	3	100	-	100
U19BM720	Project Work	EEC	0	0	16	8	100	-	100

PROFESSIONAL CORE COURSES (PCC)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
U19EC201	Electric Circuit Theory	PCC	3	0	0	3	50	50	100
U19BM301	Anatomy and Human Physiology	PCC	3	0	0	3	50	50	100
U19BM302	Bio Sensors and Measurement Devices	PCC	3	0	0	3	50	50	100
U19BM303	Fundamentals of Bio Chemistry	PCC	3	0	0	3	50	50	100
U19EC315	Digital System Design	PCC	3	0	0	3	50	50	100
U19EC316	Electron Devices and Circuits	PCC	3	0	0	3	50	50	100
U19BM304	Bio Sensors and Measurements Laboratory	PCC	0	0	2	1	50	50	100
U19BM305	Bio Chemistry and Human Physiology Laboratory	PCC	0	0	2	1	50	50	100
U19EC317	Electron Devices and Circuits Laboratory	PCC	0	0	2	1	50	50	100
U19BM406	Medical Physics	PCC	3	0	0	3	50	50	100
U19EC419	Signals and Systems	PCC	3	0	0	3	50	50	100
U19EC420	Linear Integrated Circuits	PCC	3	0	0	3	50	50	100
U19BM407	Pathology and Microbiology	PCC	3	0	0	3	50	50	100

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U19BM408	Pathology and Microbiology Laboratory	PCC	0	0	2	1	50	50	100
U19EC421	Analog and Linear Integrated Circuits Laboratory	PCC	0	0	2	1	50	50	100
U19BM509	Bio Control Systems	PCC	3	0	0	3	50	50	100
U19EC411	Digital Signal Processing	PCC	3	0	0	3	50	50	100
U19EC521	Analog and Digital Communication	PCC	3	0	0	3	50	50	100
U19BM510	Biomedical Instrumentation	PCC	3	1	0	4	50	50	100
U19EC416	Digital Signal Processing Laboratory	PCC	0	0	2	1	50	50	100
U19BM511	Biomedical Instrumentation Laboratory	PCC	0	0	2	1	50	50	100
U19EC519	Microprocessor and Microcontroller	PCC	3	0	0	3	50	50	100
U19BM612	Medical Image Processing	PCC	3	0	0	3	50	50	100
U19BM613	Diagnostic and Therapeutic Equipment - I	PCC	3	0	0	3	50	50	100
U19BM614	Medical Image Processing Laboratory	PCC	0	0	2	1	50	50	100
U19EC522	Microprocessor and Microcontroller Laboratory	PCC	0	0	2	1	50	50	100
U19BM716	Diagnostic and Therapeutic Equipment - II	PCC	3	0	0	3	50	50	100
U19BM717	Radiological Equipments	PCC	3	0	0	3	50	50	100
U19BM718	Diagnostic and Therapeutic Equipment Laboratory	PCC	0	0	2	1	50	50	100

PROFESSIONAL ELECTIVE (PE)

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME01	Bio MEMS	3	0	0	3	50	50	100
U19BME02	Nano Technology and Applications	3	0	0	3	50	50	100
U19BME03	Biomaterials and Artificial organs	3	0	0	3	50	50	100
U19BME04	Medical Optics	3	0	0	3	50	50	100
U19BME05	Human Rights	3	0	0	3	50	50	100
U19BME06	Total Quality Management	3	0	0	3	50	50	100

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U19BME07	Foundation Skills in Integrated Product Development	3	0	0	3	50	50	100
U19BME08	Artificial organs and Implants	3	0	0	3	50	50	100
U19BME09	Telehealth Technology	3	0	0	3	50	50	100
U19BME10	Biofluids and Dynamics	3	0	0	3	50	50	100
U19BME11	Intellectual Property Rights	3	0	0	3	50	50	100
U19BME12	Physiological Modeling	3	0	0	3	50	50	100
U19BME13	Robotics in Medicine	3	0	0	3	50	50	100
U19BME14	Internet of Things	3	0	0	3	50	50	100
U19BME15	Soft Computing Techniques	3	0	0	3	50	50	100
U19BME16	Acoustics and Optical Imaging	3	0	0	3	50	50	100
U19BME17	Disaster Management	3	0	0	3	50	50	100
U19BME18	Virtual Reality and Augmented Reality	3	0	0	3	50	50	100
U19BME19	Hospital Waste Management	3	0	0	3	50	50	100
U19BME20	Neural Engineering	3	0	0	3	50	50	100
U19BME21	Biometric Systems	3	0	0	3	50	50	100
U19BME22	Professional Ethics in Engineering	3	0	0	3	50	50	100
U19BME23	Electrical Safety and Quality Assurance	3	0	0	3	50	50	100
U19BME24	Ergonomics	3	0	0	3	50	50	100
U19BME25	Brain Computer Interface and its Applications	3	0	0	3	50	50	100
U19BME26	Embedded and Real time Systems	3	0	0	3	50	50	100
U19BME27	Fundamentals of Nano Science	3	0	0	3	50	50	100
U19BME28	Dental Engineering	3	0	0	3	50	50	100
U19BME29	Medical Simulation in Life Supporting Devices	3	0	0	3	50	50	100
U19BME30	Home Medicare Technology	3	0	0	3	50	50	100
U19BME31	Design and Development of Medical Devices	3	0	0	3	50	50	100
U19BME32	Medical Simulation in Cardiology	3	0	0	3	50	50	100
U19BME33	Biomechanics	3	0	0	3	50	50	100

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U19BME34	Machine Learning Techniques in Medicine	3	0	0	3	50	50	100
U19BME35	Computational Methods For Signal and Image Processing	3	0	0	3	50	50	100
U19BME36	Biosignal Processing	3	0	0	3	50	50	100
U19BME37	Wearable Systems	3	0	0	3	50	50	100
U19BME38	Body Area Networks	3	0	0	3	50	50	100
U19BME39	Neural Networks and its Applications	3	0	0	3	50	50	100
U19BME40	Medical Expert Systems	3	0	0	3	50	50	100
U19BME41	Hospital Management	3	0	0	3	50	50	100
U19BME42	Bone Densitometry	3	0	0	3	50	50	100
U19BME43	Sensory and Motor Rehabilitation	3	0	0	3	50	50	100
U19BME44	Medical Informatics	3	0	0	3	50	50	100
U19BME45	Medical Equipment, Maintenance and Troubleshooting	3	0	0	3	50	50	100
U19BME46	ICU and Operation Theatre Equipment	3	0	0	3	50	50	100
U19BME47	Ambulatory Services	3	0	0	3	50	50	100
U19BME48	Hospital Management	3	0	0	3	50	50	100

MANDATORY COURSES (MC)

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
U19MCFY1	Environmental Science and Engineering	MC	3	0	0	0	100	-	100
U19MCFY2	Indian Constitution and Universal Human Values	MC	3	0	0	0	100	-	100
U19MCSY3	Numerical Ability	MC	3	0	0	0	100	-	100
U19MCSY4	Verbal Ability	MC	3	0	0	0	100	-	100
U19MCTY5	Logical Reasoning	MC	3	0	0	0	100	-	100
U19MCTY6	Personality Development	MC	3	0	0	0	100	-	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**

CURRICULUM

PROFESSIONAL ELECTIVE – I

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME01	Bio MEMS	3	0	0	3	50	50	100
U19BME02	Nano Technology and Applications	3	0	0	3	50	50	100
U19BME03	Biomaterials and Artificial organs	3	0	0	3	50	50	100
U19BME04	Medical Optics	3	0	0	3	50	50	100
U19BME05	Human Rights	3	0	0	3	50	50	100
U19BME06	Total Quality Management	3	0	0	3	50	50	100
U19BME07	Foundation Skills in Integrated Product Development	3	0	0	3	50	50	100
U19BME08	Artificial organs and Implants	3	0	0	3	50	50	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**

CURRICULUM

PROFESSIONAL ELECTIVE – II

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME09	Telehealth Technology	3	0	0	3	50	50	100
U19BME10	Biofluids and Dynamics	3	0	0	3	50	50	100
U19BME11	Intellectual Property Rights	3	0	0	3	50	50	100
U19BME12	Physiological Modeling	3	0	0	3	50	50	100
U19BME13	Robotics in Medicine	3	0	0	3	50	50	100
U19BME14	Internet of Things	3	0	0	3	50	50	100
U19BME15	Soft Computing Techniques	3	0	0	3	50	50	100
U19BME16	Acoustics and Optical Imaging	3	0	0	3	50	50	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**VII**

CURRICULUM

PROFESSIONAL ELECTIVE – III

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME17	Disaster Management	3	0	0	3	50	50	100
U19BME18	Virtual Reality and Augmented Reality	3	0	0	3	50	50	100
U19BME19	Hospital Waste Management	3	0	0	3	50	50	100
U19BME20	Neural Engineering	3	0	0	3	50	50	100
U19BME21	Biometric Systems	3	0	0	3	50	50	100
U19BME22	Professional Ethics in Engineering	3	0	0	3	50	50	100
U19BME23	Electrical Safety and Quality Assurance	3	0	0	3	50	50	100
U19BME24	Ergonomics	3	0	0	3	50	50	100
PROFESSIONAL ELECTIVE – IV								
U19BME25	Brain Computer Interface and its Applications	3	0	0	3	50	50	100
U19BME26	Embedded and Real time Systems	3	0	0	3	50	50	100
U19BME27	Fundamentals of Nano Science	3	0	0	3	50	50	100
U19BME28	Dental Engineering	3	0	0	3	50	50	100
U19BME29	Medical Simulation in Life Supporting Devices	3	0	0	3	50	50	100
U19BME30	Home Medicare Technology	3	0	0	3	50	50	100
U19BME31	Design and Development of Medical Devices	3	0	0	3	50	50	100
U19BME32	Medical Simulation in Cardiology	3	0	0	3	50	50	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**OPEN ELECTIVE**

CURRICULUM

LIST OF OPEN ELECTIVE

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
OPEN ELECTIVE-I									
U19BMOE1	Biotelemetry	OEC	3	0	0	3	50	50	100
U19BMOE2	Virtual Instrumentation	OEC	3	0	0	3	50	50	100
U19BMOE3	Hospital Waste Management	OEC	3	0	0	3	50	50	100
OPEN ELECTIVE-II									
U19BMOE4	Medical Robotics	OEC	3	0	0	3	50	50	100
U19BMOE5	Healthcare Management Systems	OEC	3	0	0	3	50	50	100
U19BMOE6	Biometric Systems And Their Applications	OEC	3	0	0	3	50	50	100
OPEN ELECTIVE-III									
U19BMOE7	Basics of Biomedical Instrumentation	OEC	3	0	0	3	50	50	100
U19BMOE8	Medical Informatics	OEC	3	0	0	3	50	50	100
U19BMOE9	ICU and Operation Theatre Equipments	OEC	3	0	0	3	50	50	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**101**	Regulation	**2019**
Department	**COMPUTER SCIENCE AND ENGINEERING**			Semester	**OPEN ELECTIVE**

CURRICULUM

LIST OF OPEN ELECTIVE

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
OPEN ELECTIVE-I									
U19CSOE1	Introduction to IoT	OEC	3	0	0	3	50	50	100
U19CSOE2	Ethical Hacking	OEC	3	0	0	3	50	50	100
U19CSOE3	Smart Sensor Technologies	OEC	3	0	0	3	50	50	100
U19CSOE4	Web Designing	OEC	3	0	0	3	50	50	100
U19CSOE5	Data Analytics	OEC	3	0	0	3	50	50	100
U19CSOE6	Enterprise Java	OEC	3	0	0	3	50	50	100
U19CSOE7	Open Source Software	OEC	3	0	0	3	50	50	100
U19CSOE8	Python Programming	OEC	3	0	0	3	50	50	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**102**	Regulation	**2019**
Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**			Semester	**OPEN ELECTIVE**

CURRICULUM

LIST OF OPEN ELECTIVE

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
OPEN ELECTIVE-I									
U19EEOE1	Electron Devices	OEC	3	0	0	3	50	50	100
U19EEOE2	Electrical Safety	OEC	3	0	0	3	50	50	100
U19EEOE3	Energy Auditing	OEC	3	0	0	3	50	50	100
U19EEOE4	Energy Storage Technologies	OEC	3	0	0	3	50	50	100
U19EEOE5	Biomass Energy Systems	OEC	3	0	0	3	50	50	100
U19EEOE6	Energy Efficient Lighting System	OEC	3	0	0	3	50	50	100
U19EEOE7	Soft Computing techniques	OEC	3	0	0	3	50	50	100
U19EEOE8	Electrical Systems in Industries	OEC	3	0	0	3	50	50	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**103**	Regulation	**2019**
Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**			Semester	**OPEN ELECTIVE**

CURRICULUM

LIST OF OPEN ELECTIVE

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
OPEN ELECTIVE-I									
U19ECOE1	Speech Processing	OEC	3	0	0	3	50	50	100
U19ECOE2	Biomedical Instrumentation	OEC	3	0	0	3	50	50	100
U19ECOE3	Automotive Electronics	OEC	3	0	0	3	50	50	100
OPEN ELECTIVE-II									
U19ECOE4	Satellite Communication	OEC	3	0	0	3	50	50	100
U19ECOE5	VLSI Design and Its Applications	OEC	3	0	0	3	50	50	100
U19ECOE6	Digital Image Processing	OEC	3	0	0	3	50	50	100
OPEN ELECTIVE-III									
U19ECOE7	Basics of Communication Systems	OEC	3	0	0	3	50	50	100
U19ECOE8	Wireless Sensor Networks	OEC	3	0	0	3	50	50	100
U19ECOE9	PCB Design and Fabrication	OEC	3	0	0	3	50	50	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**104**	Regulation	**2019**
Department	**INFORMATION TECHNOLOGY**			Semester	**OPEN ELECTIVE**

CURRICULUM

LIST OF OPEN ELECTIVE

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
OPEN ELECTIVE-I									
U19ITOE1	Mobile application development	OEC	0	0	3	50	50	100	100
U19ITOE2	Robotics	OEC	0	0	3	50	50	100	100
U19ITOE3	Basics of Cloud Computing	OEC	0	0	3	50	50	100	100
U19ITOE4	Introduction to Data Structures	OEC	0	0	3	50	50	100	100
U19ITOE7	Business intelligence and its Applications	OEC	0	0	3	50	50	100	100
U19ITOE8	Internet of Things	OEC	0	0	3	50	50	100	100
U19ITOE9	Introduction to Java Programming	OEC	0	0	3	50	50	100	100
U19ITOE10	Introduction to R Programming	OEC	0	0	3	50	50	100	100
U19ITO11	Ethical Hacking	OEC	0	0	3	50	50	100	100
U19ITOE12	Cyber Forensics	OEC	0	0	3	50	50	100	100
U19ITOE13	E Learning Techniques	OEC	0	0	3	50	50	100	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.Tech.**	Programme Code	**105**	Regulation	**2019**
Department	**BIOTECHNOLOGY**			Semester	-

CURRICULUM

LIST OF OPEN ELECTIVES

Course Code	Course Name	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
OPEN ELECTIVE – I									
U19BTOE1	Biology for Engineers	OEC	3	0	0	3	50	50	100
U19BTOE2	Biofuels and Bioenergy	OEC	3	0	0	3	50	50	100
U19BTOE3	Bio-Business	OEC	3	0	0	3	50	50	100
OPEN ELECTIVE –II									
U19BTOE4	Basics of Bioinformatics	OEC	3	0	0	3	50	50	100
U19BTOE5	Human Health and Nutritional Disorders	OEC	3	0	0	3	50	50	100
U19BTOE6	Waste Management	OEC	3	0	0	3	50	50	100
OPEN ELECTIVE –III									
U19BTOE7	Food Processing and Preservation Technology	OEC	3	0	0	3	50	50	100
U19BTOE8	Forensic Technology	OEC	3	0	0	3	50	50	100
U19BTOE9	Biodiversity and Bioprospecting	OEC	3	0	0	3	50	50	100

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**B.E.**	Programme Code	**107**	Regulation	**2019**
Department	**COMPUTER SCIENCE AND TECHNOLOGY**			Semester	**OPEN ELECTIVE**

CURRICULUM

LIST OF OPEN ELECTIVE

Course Code	Course Name	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	ESE	Total
OPEN ELECTIVE-I									
U19CTOE1	Foundations of Artificial Intelligence	OEC	0	0	3	50	50	100	100
U19CTOE2	Fundamentals of Information Security	OEC	0	0	3	50	50	100	100
U19CTOE3	Foundations of Data Science	OEC	0	0	3	50	50	100	100
U19CTOE4	Foundations of Machine Learning	OEC	0	0	3	50	50	100	100
U19CTOE5	Fundamental of Data Visualization	OEC	0	0	3	50	50	100	100
U19CTOE6	Computer Forensics	OEC	0	0	3	50	50	100	100

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S. No.	Category	CREDIT PER SEMESTER								Credits Total	% of Credits	Maximum Number of Credit Required as per AICTE
		I	II	III	IV	V	VI	VII	VIII			
1.	HSC	3	3			1				7	4.24	12
2.	BSC	9	9	4	4					26	15.76	25
3.	ESC	8	8		5					21	12.73	24
4.	PCC		3	18	14	15	12	8		70	42.42	48
5.	PEC					3	3	6	6	18	10.91	18
6.	OEC					3	3	3		9	5.45	18
7.	EEC						3	3	8	14	8.48	15
TOTAL		20	23	22	23	22	21	20	14	165	100	160

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**I**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MA101	**Calculus**	3	1	0	4	50	50	100

Course Objective

The Main Objective of the course is to

- Provide the information about Review of limits, continuity and differentiability.
- Understand maxima and minima of functions of two variables.
- Demonstrate Integral calculus.
- Identify the problems based on area, surface and volume..
- To Recognize the Second order linear differential equations.

Course Outcome

At the end of the course, the student should be able to,	Knowledge level
CO1: Apply Mean value theorem and Taylor's theorem.	K1,K3
CO2: Analyze Total derivative.	K2,K4
CO3: Formulate Reduction Formulae.	K3,K5
CO4: Translate Change of order of integration	K2,K5
CO5: Apply method of variation of parameters.	K3,K5

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3		2								3	2	
CO 2	3				2								3		
CO 3	3		2										3		
CO 4	3	2											3	2	
CO 5	3				2								3	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**DIFFERENTIAL CALCULUS**	Periods	**12**
Limit, continuity, differentiability, rules of differentiation, differentiation of various functions, Rolle's theorem (excluding proof), Mean value theorem (excluding proof), Taylor's theorem (excluding proof), Maxima and Minima. Physical Applications (Newton's law of cooling – Heat flow problems, Rate of decay of radioactive materials – Chemical reactions and solutions, Ohm's law, Kirchoff's law- Simple electric circuit problems).			
Unit - II	**FUNCTIONS OF SEVERAL VARIABLES**	Periods	**12**
Partial differentiation – Homogeneous functions and Euler's theorem(excluding proof) – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables(excluding proof) – Maxima and minima of functions of two variables.			
Unit – III	**INTEGRAL CALCULUS**	Periods	**12**
Riemann integral- Fundamental theorem of calculus (excluding proof) - methods of integration (Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions) -Reduction formula on $\int_0^{\frac{\pi}{2}} \cos^n x dx$, $\int_0^{\frac{\pi}{2}} \sin^n x dx$.			
Unit - IV	**MUTIPLE INTEGRALS**	Periods	**12**
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.			
Unit – V	**ORDINARY DIFFERENTIAL EQUATIONS**	Periods	**12**
Second order Linear ordinary differential equations with constant coefficients, Cauchy's - Euler equations (excluding proof)- Legendre's Linear differential equations(excluding proof) - Method of variation of parameters.			
		Total Periods	**60**

Text Books	
1.	Stewart, J. Calculus: Early Transcendentals (8th Edition), Cengage Learning, 2015.
2.	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
References	
1.	Kreyszig E, Advanced Engineering Mathematics (10th Edition), John Wiley (2015).
2.	Boyce W E and DiPrima R, Elementary Differential Equations (9th Edition), John Wiley (2005).
3.	Nishant Shukla, Elementary Integral Calculus.
4.	Anton H, Calculus: Early Transcendentals, 10th Edition, Wiley (2012).
5.	B V Ramana, Higher Engineering Mathematics, Tata McGraw Hill Education Pvt Ltd., New Delhi (2012).
E-Resources	
1.	https://freevideolectures.com › All Courses › Calculus › UCLA
2.	www.learnerstv.com/Free-engineering-Video-lectures
3.	www.nptel.ac.in

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**I**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EN101	**English for Communication – I**	3	0	0	3	50	50	100

Course Objective	The Main Objective of the course is to • Make learners listen to audio files and replicate it in speaking contexts. • Make learners read widely in order to practice writing. • Make learners develop vocabulary and strengthen grammatical understanding. • Assist students in the development of intellectual flexibility, creativity, and cultural literacy so that they may engage in life-long learning. • Identify and begin to apply the language features of academic and professional writing and speaking.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Speak adequately from the inputs they gained through listening.	K2
	CO2: Write appropriately based on the knowledge gained through reading of a variety of materials	K3
	CO3: Use language through their grammatical acquisition and their knowledge about using right word at the right context.	K3
	CO4: Listen the accents and tones of the language properly.	K2
	CO5: Comprehend and retain the contextual and syntax understanding from reading.	K4

Pre-requisites	-

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1						2			3	3		3		2	
CO 2						2			3	3		3		2	
CO 3						2			3	3		3		2	
CO 4						2			3	3		3		2	
CO 5						2			3	3		3		2	

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I		Periods	**9**

Listening-Introduction to Different Types of Listening, Listening to Casual Conversations, **Speaking**-Introduction to develop the Art of Speaking, Giving Self Introduction, **Reading**–Understanding the Basics of Reading Skills, Reading Instructions and Technical Manuals, **Writing**- Introduction to writing strategies, Writing Definitions, **Focus on Language**-Technical terms (Jargon), Word Formation with Prefixes and Suffixes, Using Active Voice and Passive Voice, Basic sentence patterns, Tenses (past, present, perfect and continuous tenses).

Unit – II		Periods	**9**

Listening- Listening to lectures, listening to description of equipment, **Speaking**- Strategies for Developing Conversational Skills, Short Conversations through Role Play Activities, **Reading**– Reading Comprehension, Reading e-mails, Reading Headlines, Predicting the Content, **Writing**- Note making, Writing Descriptions, **Focus on Language**–Collocations, Functional Use of Tenses, Subject - verb agreement

Unit – III		Periods	**9**

Listening- Listening to different kinds of interviews (Face - to - face, radio, TV and telephone interviews), **Speaking**-Describing an Object, Asking Questions, Participating in Discussions **Reading**– Intensive reading, Reading passages for gist. **Writing**- Informal writing -short e-mails with emphasis on Brevity, Clarity, Coherence and Cohesion), **Focus on Language**–Sequential Connectives, Impersonal Passive

Unit – IV		Periods	**9**

Listening-Note Taking, **Speaking**- Improving Fluency through Narration. **Reading**–Reading passages for specific information- Phone messages, Reading and Transferring Information. **Writing**- Effective writing strategies, Informal writing, Writing a Memo, **Focus on Language**– Pronunciation Practice (Phonetic sounds - Vowels, Consonants and Diphthongs), Cause and Effect, Conditional Statements (if - clauses and types), Usage of Modal Verbs.

Unit – V		Periods	**9**

Listening- Listening to understand Modulation, Listening to Welcome Speeches, **Speaking**- Delivering Welcome Address, Understanding Segmental and Supra segmental Features-Practicing Stress, Pause and Intonation, **Reading**– Reading for a purpose, Reading Business Documents, Interpreting Charts and Graphs,. **Writing**- Writing Business e-mails, Describing a Process. **Focus on Language** -Synonyms and Antonyms, Common Errors in English.

	Total Periods	**45**

Text Books

1.	Sumant. s, Pereira Joyce, Shameem.M, Selvarajan.R-English Communication Skills,Vijay Nicole imprints Pvt.Ltd, 2015.
2.	Sokkaalingam, S.RM., The Art Of Speaking EnglishVersatile Publishing House,2018.

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References	
1.	Dr. Padma Ravindran, Poorvadevi, M. Y. Abdur Razack- English for life, English for work, students Book, Ebek language laboratory pvt ltd, 2011.
2.	Dutt Rajeevan, Prakash. A Course in Communication Skill (Anna University, Coimbatore edition): Cambridge University Press India Pvt.Ltd, 2007.
3.	S.P. Dhanavel, English and Communication Skills for Students of Science and Engineering, Orient Blackswan Pvt, Ltd, 2009.
4.	Technical English – I & II, Sonaversity, Sona College of Technology, Salem, First Edition, 2012.
5.	Meenakshmi Raman and Sangeeta Sharma- 'Technical communication English Skills for Engineers; oxford University Press, 2008.
E-Resources	
1.	http://www.sparknotes.com/lit/the-alchemist/summary.html
2.	https://www.stephencovey.com/7habits/7habits.php
3.	http://en.wikipedia.org/wiki/The_Seven_Habits_of_Highly_Effective_People

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**I**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CH105	**Engineering Chemistry**	3	0	0	3	50	50	100

Course Objective	The Main Objective of the course is to • Recognize the basic technology requirements in water treatment. • Gain knowledge in Polymeric materials towards engineering applications. • Enrich the Knowledge of the students with the basics of Nano materials, their properties and applications. • Familiarize about the renewable energy and different types of batteries in the engineering application. • Gain knowledge in destruction of metals and protection for engineering applications.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Implement innovative solutions in old Water treatment process.	K3
	CO2: Identify the application of a specific polymer in the field of engineering.	K2
	CO3: Forecast the information of Nanoparticles and their industrial applications.	K2
	CO4: Recognize the renewable energy devices produce sustainable energy.	K3
	CO5: Identify the rate of corrosion of a metal in a given environment and spot appropriate control techniques to avoid corrosion.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	2		2	2				1	2	1	1	2
CO 2	3	2	2	1		2	2				1	1	2	2	2
CO 3	3	2	3	2	1	2	1				1	1	1	1	1
CO 4	3	3	2	2	2	3	3				1	2	3	2	2
CO 5	3	3	2	2	1	3	2				2	2	1	1	2

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit - I	**WATER TECHNOLOGY**	Periods	**9**

Introduction-Sources and impurities in Water-Soft and Hard water- Water quality parameters-types of Hardness –Determination of Hardness by EDTA method-Domestic Water Treatment. Boiler Feed Water-Requisites-Problems due to hard water in boilers-Scale and Sludge formation in boilers-Caustic embrittlement-Boiler corrosion-Treatment of boiler feed Water– Internal conditioning (Carbonate, Phosphate, and Calgon conditioning) external conditioning – Ion exchange process, Zeolite process – Brackish water – Water purification by Reverse osmosis.

Unit - II	**POLYMER CHEMISTRY**	Periods	**9**

Introduction- Occurrence, definitions – Functionality- Degree of Polymerization-Classification of polymers – structure (Linear, Branched & network polymer structure) block, random & graft copolymers, - properties of polymers, Tacticity, Tg, molecular weight-number and weight average method . Types of polymerizations: Addition, condensation and copolymerization. Mechanism of polymerization: Addition (Free radical, cationic and anionic polymerization). Preparation, properties and applications of PE, PMMA, PC, nylon6, nylon 66, PET, and Bakelite.

Unit - III	**NANO CHEMISTRY**	Periods	**9**

Basics- distinction between molecules, nanoparticles and bulk materials; size dependent properties. Nanoparticles: nanocluster, nanorod, nanotube (CNT) and nanowires. Synthesis: Sol-gel, Precipitation, Thermolysis-hydrothermal, solvothermal, Electro deposition, Spray Pyrolysis, Chemical Vapour deposition, Laser ablation; properties and applications of nano materials in medical and electronic devices.

Unit - IV	**RENEWABLE ENERGY AND STORAGE DEVICES**	Periods	**9**

Renewable energy and its sources - Solar Energy-Photo voltaic cells-Importance of Solar cells-p-n junctions in Solar cells- Working of Photovoltaic cell-Recent advances in solar cell materials -Wind energy- Types of Wind Power Plants(WPPs)–Components and working of WPPs-Tidal energy- Types of Tidal power plants(TPPs), Barrage and Non Barrage Tidal power systems.

Batteries and fuel cells: Types of batteries- Dry cells-Alkaline battery –lead storage battery-Ni-Cd battery-lithium battery- Fuel cell; H_2-O_2 fuel cell-applications.

Unit - V	**CORROSION AND ITS CONTROL**	Periods	**9**

Introduction-Types of corrosion- chemical and electrochemical corrosion-mechanism , Pilling -Bedworth rule– Types of electrochemical corrosion — galvanic corrosion -Pitting corrosion, Crevice corrosion, Corrosion on wire fence and Pipeline corrosion-Factors influencing rate of corrosion– corrosion control methods – Sacrificial anode and Impressed cathodic current.

Protective coatings – Paints : constituents and function - Metallic coatings-steps involved in cleaning the surface for Electroplating,Electroplating (Au)-Electro less plating (Ni).

Total Periods	**45**

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Text Books	
1.	O.G.Palanna, "Engineering Chemistry "Tata Mc GrawHill PVT,Ltd. Second Edition -2017.
2.	Dr.S.Vairam ,Dr.S.Mageswari,Dr.K.Balachandran, Engineering Chemistry : First Edition, Wiley publication,Reprint-2016.
References	
1.	Engineering Chemistry: Jain & Jain, Dhanpat Rai Publishing Company Edition- 16- 2015.
2.	Arun Bahl, B.S. Bahl, G.D. Tuli, Essentials of Physical Chemistry, Published by S. Chand & Company Ltd, 2014.
3.	Puri, Sharma and Pathnia, Physical Chemistry-II, Vishal Publishers,.Edition- 2019.
4.	Engineering Chemistry: Sashi Chawla, Dhanpat Rai & Co (pvt.)ltd. Edition- 5- 2013.
5.	Dr.S.Vairam ,Dr.Suba Ramesh, Engineering Chemistry: First Edition, Wiley publication,Reprint-2016.
E-Resources	
1.	https://www.who.int/water_sanitation_health/dwq/arsenicun6.pdf
2.	https://www.schandpublishing.com/books/tech-professional/applied-science/a-textbook-polymer-chemistry/9788121941129/#.XdZ214MzY2w
3.	https://www.elsevier.com/books/nanochemistry/klabunde/978-0-444-59397-9

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**I**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CS101	**Programming for Problem Solving**	3	0	0	3	50	50	100

Course Objective

The Main Objective of the course is to

- Learn the fundamentals of computers and acquire problem solving.
- Understand C programming concepts.
- Write the programs using arrays and strings.
- Write the programs using functions.
- Write the programs using structures.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Write the algorithms and to draw flowcharts for solving problems.	K3
	CO2: Analyze the basics of C programming language.	K4
	CO3: Implement the C programs using arrays and strings.	K4
	CO4: Develop C programs using the functions and pointers.	K3
	CO5: Solve the real time problems using Structures and union	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3		2			3	3	3	3	2	3		
CO 2	3	3	3		2			3	3	3	3	2	3		
CO 3	3	3	3		2			3	3	3	3	2	3		
CO 4	3	3	3	2	2			3	3	3	3	2	3		
CO 5	3	3	3	3	2			3	3	3	3	2	3	3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION TO PROBLEM SOLVING**	Periods	**9**
Basic Organization of Computer - Programming Languages- Flowchart – Pseudocode - Compilers-Interpreter-Algorithm - Building Blocks of Algorithm - Algorithmic Problem Solving-Simple Strategies for Developing Algorithms - Illustrative Problems: Find Minimum value from list of elements, Guess an Integer Number in a Range, Factorial of a given number.			
Unit - II	**C PROGRAMMING**	Periods	**9**
Introduction to C – Features - Data Types – Constants – Variables - I/O Statement - Operators –Expressions - Decision Making and Branching – Looping Statements - Break, Goto, Continue.			
Unit – III	**ARRAYS AND STRINGS**	Periods	**9**
Arrays: Concepts – Need – one dimensional array – array declaration – features – array initialization - Two-Dimensional Arrays- Multidimensional Arrays. Strings: Concepts – Strings manipulation - String Input / Output Functions- Strings standard functions - Arrays of Strings.			
Unit – IV	**FUNCTIONS AND POINTERS**	Periods	**9**
Function: Introduction, function declaration, defining and accessing functions, User-defined Functions- storage classes-function prototypes-parameter passing methods-recursion. Pointers: Introduction, pointer declaration-accessing variable through pointer-pointers and Arrays, Pointers and strings – Pointers structures-pointer Arithmetic - Array of Pointers – dynamic memory allocation.			
Unit – V	**STRUCTURES AND UNIONS**	Periods	**9**
Structures-Introduction- nested structures- Arrays of Structures - Structures and Functions - Pointers to Structures – Unions- Type Definition – Bitfields- Enumerated Types.			
		Total Periods	**45**

Text Books	
1.	Kernighan BW and Ritchie DM, "The C Programming Language", 2nd Edition, Prentice Hall of India, 2015.
2.	E. Balagurusamy, Computer Programming, First Edition, Mc Graw Hill, 2016.
References	
1.	Herbert Schildt, C: The Complete Reference, Mc Graw Hill, 4th Edition.
2.	Dr.V.Rameshbabu, Dr.R.Samyutha, M.Muni Rathnan, "Computer Programming", VRB Publishers Pvt.Ltd.
3.	E. Balagurusamy, Programming in ANSI C, Seventh Edition, Mc Graw Hill, 2017.
E-Resources	
1.	https://www.geeksforgeeks.org/c-language-set-1-introduction/
2.	https://www.programiz.com/c-programming
3.	https://www.cprogramming.com/

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19GE101	**Engineering Graphics**	2	0	3	3	50	50	100

Course Objective

The Main Objective of the course is to

- Develop skills to enhance their ability to know the concept of engineering graphics and to draw the points kept in various positions, lines and planes.
- Project the drawing of various solids.
- Sketch sectioned views of solids.
- Draw the development of surfaces.
- Draw the isometric and orthographic projections for any given object to the required standard.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Construct plane curves and develop projection of points , lines and plane surfaces.	K2
	CO2: Construct projection of solids with various conditions.	K4
	CO3: Design the section of solids and analyze the true shape of the section.	K3
	CO4: Design and develop the different solid surfaces.	K2
	CO5: Construct isometric and orthographic projection of different solids.	K1

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3	3	3								2		
CO 2	3	3	2	2	2								2		
CO 3	3	2	2	2	3								2	2	
CO 4	3	2	3	3	2								2		
CO 5	3	3	2	2	3								2	2	

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examination

Indirect

1. Course - end survey

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Content of the syllabus			
Concepts & Conventions (Not for Examination)	Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.	Periods	**1**
Unit – I	**PROJECTION OF POINTS, LINES AND PLANE SURFACES**	Periods	**3+8**
Introduction to Plane curves, Orthographic projection – principles – projection of points, straight lines (only first angle projections) and plane surfaces (polygonal and circular).			
Unit – II	**PROJECTION OF SOLIDS**	Periods	**3+8**
Projections of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane.			
Unit – III	**SECTION OF SOLIDS**	Periods	**3+8**
Sectioning of solids - prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other - Obtaining true shape of section.			
Unit – IV	**DEVELOPMENT OF SURFACES**	Periods	**3+8**
Development of lateral surfaces of simple solids like prisms, pyramids, cylinders and cones – development of simple truncated solids involving prisms, pyramids, cylinders and cones.			
Unit – V	**ISOMETRIC PROJECTIONS, ORTHOGRAPHIC VIEWS FROM PICTORIAL VIEW**	Periods	**5+10**
Isometric Projection and Introduction to AutoCAD / Solid Edge: Principles of isometric projection - Isometric scale -Isometric projections of simple solids like prisms, pyramids, cylinders and cones & orthographic views from pictorial views.			
Demonstration only: **Computer Aided Drafting (Auto CAD / Solid Edge):** Introduction to drafting packages and demonstration of their use.			
		Total Periods	**60**
Text Books			
1.	Basant Agrawal and C.M Agrawal ,"Engineering Drawing ",Tata McGraw Hill ,Third Edition,2019.		
2.	Jain and Gautam ,"Engineering Graphics & Design ",Khanna Publishing House, 2018.		
References			
1.	Dr.P.Kannan and Dr.J.Bensam Raj, "Engineering Graphics", JBR Tri Sea Publishers Pvt. Ltd.2018.		
2.	K.V Natarajan,"Engineering Drawing and Graphics", M/s. N.Dhanalakshmi, Chennai,2014.		
3.	K.Venugopal and V.Prabhu Raja, "Engineering Graphics" New Age International Publishers.2011.		
4.	N.S Parthasarathy and Velamurali," Engineering Graphics", Oxford University, New Delhi.2015.		
5.	Bhatt N.D and Panchal V.M, "Engineering Drawing", Charotar Publishing House,50th Edition.2010.		
E-Resources			
1.	http://nptel.ac.in/courses/105104148, "Engineering Graphics" - Dr. Nihar Ranjan Patra , IIT Kanpur		
2.	http://cfd.annauniv.edu/webcontent.htm, "Engineering Graphics" - Dr.Velamurali		
3.	http://link.springer.com/ "Engineering Graphics"-Springer Nature.		

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
(Autonomous Institution, Affiliated to Anna University ,Chennai)
Elayampalayam, Tiruchengode – 637 205

Programme	B.E	Programme Code	106	Regulation	2019
Department	BIOMEDICAL ENGINEERING			Semester	I

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CH106	Chemistry Laboratory	0	0	4	2	50	50	100

Course Objective

The Main Objective of the course is to

- Gather basic simple acid-base reactions and study the mechanism of acid mixture with base.
- Learn pH and potential of hydrogen in a sample solution.
- Study the redox reaction through potential difference.
- Quote iron forms complex with thio cyanate.
- Gather knowledge on hardness producing salts and removal of hardness through estimation.
- Collect data required for dissolved oxygen present in water sample.
- Understand alkalinity and available chlorine present in water sample

Course Outcome

At the end of the course, the student should be able to,	Knowledge level
CO1: Infer knowledge on neutralization reaction between acid, acid mixture with base and identify the concentrations.	K3
CO2: Spot the concentration of sample solution through potential of hydrogen and redox reaction.	K3
CO3: Estimate Iron by complexation reaction spectrometrically.	K5
CO4: Determine hardness and dissolved oxygen present in domestic water supply.	K5
CO5: Identify alkalinity and available chlorine present in the given sample.	K5

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												PSOs		
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3		2	2	1	1					2	2	2	2
CO 2	3	3		2	1							1	2	1	2
CO 3	3	3		2	1								1	2	2
CO 4	3	3	1	2	2	2	2					2	2	2	
CO 5	2	3	1	2	2	2	2					2	2	2	

Course Assessment Methods

Direct
1. Pre lab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

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LIST OF EXPERIMENTS	
1. Conductometric titration (Simple Acids and Bases) 2. Conductometric titration (Mixture of weak and Strong Acids) 3. Conductometric titration (Precipitation titration) 4. Potentiometric titration (Fe^{2+} /$KMnO_4$ or $K_2Cr_2O_7$) 5. pH metric titration (Acids and Bases). 6. Estimation of Ferric ion by Spectrophotometry. 7. Determination of Total hardness, temporary and permanent hardness of water by EDTA method. 8. Estimation of Dissolved Oxygen content in water by Winkler's method. 9. Estimation of alkalinity in water sample. 10. Estimation of available chlorine in bleaching powder.	
Total Periods	**45**
Lab Manuals suggested:	
1.	Chemistry laboratory I & II by Dr.A.Ravikrishnan,Sri Krishna Pub, Revised Edition-2017.
2.	Chemistry laboratory Manual by Dr.Veeraiyan, Revised Edition-2017.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**			Semester			**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CS102	**Computer Practices Laboratory**	0	0	4	2	50	50	100

Course Objective

The Main Objective of the course is to

- Make the students to learn the programming language.
- Understand the basic programming constructs and articulate how they are used.
- Develop a program with a desired runtime execution flow.
- Articulate where computer programs fit in the provision of computer based solutions to real world problems.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Prepare document using word processor.	K3
	CO2: Sketch flow of execution of C programs using algorithm and flowcharts.	K3
	CO3: Write the simple C Programs using decision and looping statements.	K3
	CO4: Demonstrate code reusability with the help of user defined functions and pointers.	K4
	CO5: Write programs that perform operations using derived data types.	K3

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

CO/PSO Mapping																
COs	Programme Outcomes (POs)												PSOs			
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3	1				3	3	3	3	3	3	1	
CO 2	3	3	3	1				3	3	3	3	3	3	1	
CO 3	3	3	3	1				3	3	3	3	3	3	1	
CO 4	3	3	3	3				3	3	3	3	3	3	1	
CO 5	3	3	3	3				3	3	3	3	3	3	1	

Course Assessment Methods

Direct
1. Pre lab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

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SUGGESTED LIST OF EXPERIMENTS

1. Design an algorithm and flowchart using word processor that reads the customer number and power consumed and prints the amount to be paid by the customer. An electric power distribution company charges its domestic consumers as follows

Consumption Units	Rate of Charge
0-200	Rs.0.50 per unit
201-400	Rs.100 plus Rs.0.65 per unit excess 200
401-600	Rs.230 plus Rs.0.80 per unit excess of 400.

2. Design an algorithm and flowchart for a simple calculator program using word processor for performing various arithmetic operations such as

"+" - Addition

"-" - Subtraction

"*" - Multiplication

"/" - Division

"%" - Modulus

3. Design and develop a C program to accept a number from the user and check whether it is a palindrome or not.

Palindrome number : (a number is a Palindrome which when read in reverse order is same as read in the right order)

Example: Palindrome :11, 101, 151

Not a Palindrome:123 , 100

4. Develop a C program to find the sum of the digits of an integer and the number of digits in the integer that is given as input by the user.

Test Case:

Sample Input: 15390

Sample Output:
Sum of the digits=18
No. of digits = 5
For an incorrect choice, an appropriate error message should be displayed.

5. Develop a program to perform the following operations using two dimensional or multi-dimensional

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matrices:

a. Addition of two matrices (3x3)

b. Subtraction of two matrices (2x2)

c. Multiplication of two matrices using dynamic memory allocation.

6. Write a program to find the maximum and minimum element in a set of inputs using one dimensional array.

7. Write a program to count the total number of vowels and consonants in a string. For example

Input string: I am proud to be an Indian

Output: Total vowels – 10 and Total consonants - 10

8. Develop a program to perform the following string manipulations without using string functions:

d. String copy

e. String Concatenate

f. String length

g. String Compare

9. The Fibonacci numbers are defined recursively as follows:

F1=1

F2=1

Fn= Fn-1 + Fn-2, n>2

Write a function that will generate and print the first n Fibonacci numbers.

Test the function for n=5,10,15

10. Write a function using pointers to exchange the values stored in two locations in the memory.

Test Case :

Input : A=10 , B=-5

Output : A= -5 , B=10

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11. Develop a program to build a database of students with the following attribute: Roll no, Name, Course, Stream, Percentage, and Division. Take input for each student in all fields except division. Calculate division of each student such that those students having percentage >=60% are belongs to first division. Similarly, for second and third division students having conditions 50 %< =percentage<60% and 35 %< =percentage<50% respectively. If any student has percentage less than 35% then write "fail" in division field. After building the database display the database of the students. Hint: create database using structure.	
Total Periods	**45**
E-Resources	
1.	https://www.programiz.com/c-programming
2.	https://www.cprogramming.com/
3.	https://beginnersbook.com/2015/02/simple-c-programs/

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**I**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCFY2	**Indian Constitution and Universal Human Values**	3	0	0	0	100	-	100

Course Objective	The Main Objective of this course is to: • Know about Indian constitution. • Know about central and state government functionalities in India. • Know about Indian society.	
Course Outcome	At the end of the course, the student will be able to	Knowledge Level
	CO1: Understand the functions of the Indian government.	K1
	CO2: Understand and abide the rules of the Indian constitution.	K1
	CO3: Understand and appreciate different culture among the people.	K1
	CO4: Understanding human being as a co-existence of the sentient 'I' and the material.	K1, K2
	CO5: 'Body' and the needs of Self ('I') and 'Body' and Ability to utilize the professional competence for augmenting universal human order and Ability to identify the scope and characteristics of people-friendly and ecofriendly Production systems.	K2
Pre-requisites	---	

CO / PO Mapping
(3/2/1 indicates strength of correlation) 3-**Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1						3		3	2						
CO 2						3		3	3						
CO 3						3		3	2						
CO 4						3		3	3						
CO 5						3		3	3						

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION**	Periods	**9**
Historical Background – Constituent Assembly of India – Fundamental Rights – Citizenship – Constitutional Remedies for citizens.			
Unit - II	**STRUCTURE AND FUNCTION OF CENTRAL**	Periods	**9**
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India.			
Unit – III	**STRUCTURE AND FUCTION OF STATE**	Periods	**9**
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.			
Unit - IV	**UNIVERSAL HUMAN VALUES**	Periods	**9**
Course Introduction - Need, Basic Guidelines, Content and Process for Value Education.			
Unit – V	**OPTOEL UNIVERSAL HUMAN VALUES - PROFESSIONAL ETHICS ECTRONICS**	Periods	**9**
Understanding Harmony in the Human Being - Harmony in Myself and society.			
		Total Periods	**45**

Text Books	
1.	Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.
2.	Tanu shukla,Human Values and professional Ethics, Cengage publications.
References	
1.	R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi
2.	Indian polity, M.Laksmikanth,Tatamchrawhill publications
3.	R R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics,Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2
E-Resources	
1.	https://mhrd.gov.in/
2.	https://niti.gov.in/content/niti-aayog-library
3.	www.drishtiias.com/

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Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**II**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MA202	**Linear Algebra and Ordinary Differential Equations**	3	1	0	4	50	50	100

Course Objective	The Main Objective of the course is to • Understand Eigen values and Eigen vectors and its role in the system of equations. • Proficiently understand the vector differential calculus. • Demonstrate vector integral calculus. • To know about Cartesian and Polar co-ordinates and also transformations. • Identify the Laplace transform of derivatives and integrals.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Analyze the Reduction of a quadratic form.	K3, K4
	CO2: Identify vector differential calculus.	K2, K3
	CO3: Apply Green's, Stoke's and Gauss Divergence theorems.	K1, K5
	CO4: Identifying the analytic functions.	K2, K5
	CO5: Recognize the Laplace transform of unit step and unit impulse functions.	K5, K3
Pre-requisites	-	

O / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3										3		
CO 2	3				2								3		
CO 3	3		2										3	2	
CO 4	3	3											3	2	
CO 5	3				2								3	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**MATRICES**	Periods	**12**
Characteristic equation – Eigen values and Eigenvectors of a real matrix– Properties of Eigen values and Eigenvectors – Cayley-Hamilton theorem(excluding proof) – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.			
Unit – II	**VECTOR DIFFERENTIAL CALCULUS**	Periods	**12**
Vector Differentiation: Vector and Scalar Functions- Derivatives- Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar Field-Directional Derivative -Divergence of a Vector Field - Curl of a Vector Field.			
Unit – III	**VECTOR INTEGRAL CALCULUS**	Periods	**12**
Line, Surface and Volume integrals, Green's theorem in a plane(excluding proof), Gauss Divergence theorem(excluding proof), Stokes theorem (Excluding proof) - simple applications involving rectangular parallelepipeds and spheres.			
Unit – IV	**ANALYTIC FUNCTIONS**	Periods	**12**
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions c+z, cz,1/z and Bilinear transformation.			
Unit – V	**LAPLACE TRANSFORMS**	Periods	**12**
Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems(excluding proof) -Transforms of derivatives and integrals – Initial and final value theorems(excluding proof) – Inverse transforms – Convolution theorem(excluding proof) – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.			
		Total Periods	**60**

Text Books	
1.	T.Veerarajan, Engineering Mathematics, Tata McGraw Hill Education Pvt. Ltd-2012.
2.	Ravish R Sing , Mukul Bhatt, "Engineering Mathematics", Mc Graw Hill Education Pvt. Ltd-2018.
References	
1.	Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics" , Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
2.	Kreyszig, E., Advanced Engineering Mathematics (10th Edition), John Wiley (2015).
3.	Alan Jefferis , Advanced Engineering Mathematics,Academic Press- New Delhi-2003.
4.	Yunus A.Cengel, William J.Palm III," Differential equations for Engineers & Scientists", Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
5.	John Bird, Higher Engineering Mathematics, Anuradha Agencies(2004).
E-Resources	
1.	https://en.wikipedia.org › wiki › Ordinary_differential_equation
2.	www.learnerstv.com/Free-engineering-Video-lectures
3.	www.nptel.ac.in

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Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**II**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EN202	**English for Communication – II**	3	0	0	3	50	50	100

Course Objective	The Main Objective of the course is to • Provide suitable listening tasks to develop communicative ability for academic and professional progress. • Inculcate channelized reading to make learners proficient in the chosen professional writing contexts. • Improve learners' vocabulary and grammar to supplement their language use at professional contexts. • Assist students in the development of intellectual flexibility, creativity, and cultural literacy so that they may engage in life-long learning. • Identify and begin to apply the language features of academic and professional writing and speaking.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Acquire sufficient command over language to speak at an academic or professional context through continuous exposure to similar listening tasks.	K2
	CO2: Write technically well at a professional contexts through exposing them to similar readings.	K3
	CO3: Use language at length at technical and professional situations through the enrichment of vocabulary and strengthening of grammatical knowledge.	K3
	CO4: Students should be able to ethically gather, understand, evaluate and synthesize information from a variety of written and electronic sources.	K2
	CO5: Students should be proficient in oral communication and writing.	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1						2			3	3		3		2	
CO 2						2			3	3		3		2	
CO 3						2			3	3		3		2	
CO 4						2			3	3		3		2	
CO 5						2			3	3		3		2	

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Course Assessment Methods

Direct
1.Continuous Assessment Test I, II & III 2.Assignment: Simulation using tool 3.End-Semester examinations
Indirect
1.Course – end survey

Content of the syllabus

Unit – I		Periods	**9**
Listening- Listening for Cultural Awareness, Listening to Professional Conversations, Talks, Interviews and Lectures **Speaking-** Developing Confidence to get rid of Fear on the Dias, Discussion at a Corporate Context. **Reading** – Inferential Reading, Reading Short Messages and Technical Articles, **Writing-** Introduction to Letter Writing, Writing Formal and Informal Letters, Thanking Letters, Letters Calling for Quotations, Letters Placing an Order, Seeking clarification, Letters of Complaint. **Focus on Language** – Adjectives and Degrees of Comparisons.			
Unit – II		Periods	**9**
Listening- Listening to specific information relating to technical content, Listening for statistical information **Speaking-** Expressing opinions, Formal Discussions, Describing Role Play at Business Context and Consolidating Ideas. **Reading** –Reading Technical Articles in Journals and Comparing Articles. **Writing-** Letter seeking permission to undergo practical training and to undertake project work. **Focus on Language** – Simple, compound and complex sentences and Transformation of Sentences.			
Unit – III		Periods	**9**
Listening- Listening to understand the overall meaning, Listening to Interviews and Presentations. **Speaking-** Giving Instructions and Showing Directions and Rephrasing Instructions. **Reading** – Skimming and Scanning, Reading Job Advertisements. **Writing**- Applying for a Job, Writing a CV. **Focus on Language** – Pronouns, Phrasal verbs, Restrictive and Non - restrictive clauses.			
Unit – IV		Periods	**9**
Listening- Listening and retrieving Information.**Speaking-** Developing fluency and Coherence, Accent Neutralization, Voice Modulation, and Intonation, Improving Voice Quality. **Reading** – Reading and understanding Advertisements. **Writing-** Letters to the Editor, Letter of Complaint, Various kinds of Reports, Permission to go for Industrial visits. **Focus on Language** – Countable, Uncountable nouns, Recommendations, Discourse Markers and Comparative and Contrastive Connectives, Imperatives.			
Unit – V		Periods	**9**
Listening- Listening to Fragmented Texts and Filling in the Blanks. **Speaking-** Mind Mapping, Developing Coherence and Self-Expression, Making presentations, Paralinguistic and Extra linguistic Features (body language), **Reading** – Predicting content, Interpreting Reports. **Writing-** Writing Proposals, Agenda, Minutes of the Meeting. **Focus on Language** – British and American Vocabulary, Editing, Error Detection, and Punctuation.			
		Total Periods	**45**

Text Books

1.	Sumant.S,Pereira Joyce, English for Communication, Vijay Nicole Imprints Pvt.Ltd., 2014.
2.	Sokkaalingam, S.RM., The Art Of Speaking EnglishVersatile Publishing House,2018.

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References	
1.	Norman Whitby - Business Benchmark Pre-Intermediate to Intermediate, Students Book, Cambridge University Press, 2008. , 1997.
2.	Dutt, Rajeevan, Prakash .A Course in Communication Skills (Anna University, Coimbatore edition) :. Cambridge University Press India Pvt.Ltd, 2007.
3.	Meenakshi Raman and Sangeeta Sharma-'Technical Communication English Skills for Engineers'; Oxford University Press, 2008.
4.	S.P. Dhanavel, English and Communication Skills for Students of Science and Engineering, Orient Blackswan Pvt, Ltd, 2009.
5.	Technical English – I & II, Sonaversity, Sona College of Technology, Salem, First Edition, 2012.
E-Resources	
1.	http://www.kalevleetaru.com/Publish/Book_Review_Who_Moved_My_Cheese.pdf
2.	http://www.bookbrowse.com/reviews/index.cfm/book_number/304/who-moved-my-cheese
3.	http://www.imdb.com/title/tt0482629/plotsummary

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**II**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19PH207	**Engineering Physics**	3	0	0	3	50	50	100

Course Objective	The Main Objective of the course is to • Understand the basic concepts of properties of matter. • Gain knowledge about the conduction properties of metals. • Identify the different types of crystal structures and crystal growth techniques. • Study the production and applications of ultrasonics correlate better understanding the carrier concentration and its variations with temperature in a semiconductor. • Study the properties of modern engineering materials and its uses categorize the types of laser and fiber optics.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Understand the elastic properties of the materials.	K2
	CO2: Gain knowledge about the conduction properties of metals.	K3
	CO3: Determine packing factor for various unit cells and understand different types of crystal imperfections and learn the engineering, medical applications.	K1
	CO4: Discuss the basic idea of semiconducting materials and realize the function of modern engineering materials.	K1
	CO5: Learn the optical properties of materials and its uses.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2	3	1	2									2	
CO 2	3	2	3	3	1										
CO 3	3	3		3	1									2	
CO 4	3		2	1	1								3	2	
CO 5	3			1	2	2								2	

Course Assessment Methods

Direct
1.Continuous Assessment Test I, II & III 2.End-Semester examinations
Indirect
1.Course - end survey

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Content of the syllabus			
Unit – I	**PROPERTIES OF MATTER**	Periods	**9**
Elasticity: Introduction - Hooke's Law - Stress - Strain Diagram -Young's modulus: theory and experiment (uniform and non-uniform bending) - Twisting couple on a cylinder- Torsional pendulum: Rigidity modulus and moment of inertia. **Viscosity:** Co-efficient of viscosity and its dimensions - Rate of flow of liquid in a capillary tube - Poiseuilles' formula - Experimental determination of co-efficient of viscosity of a liquid - Applications of viscosity.			
Unit – II	**ELECTRONS IN SOLID**	Periods	**9**
Classical theory: Classical free electron theory of metals- Expressions for electrical conductivity and Thermal Conductivity of metals – Wiedemann-Franz law- Success and failures of Classical free electron theory. **Quantum theory:** Quantum free electron theory- de Broglie's hypothesis - Schrodinger's time independent and time dependent wave equations - Particle in a one-dimensionalbox (Qualitative)- Fermi – Dirac Statistics- Density of energy states (Qualitative).			
Unit – III	**CRYSTAL PHYSICS AND ULTRASONICS**	Periods	**9**
Crystalline solids and amorphous solids- Lattice - Unit cell - Crystal system - Bravais lattices- Lattice planes - Miller indices - Derivation of inter-planar spacing in cubic lattice- Calculation of number of atoms per unit cell- Atomic radius – Coordination number- Packing Factor for HCP structures - Crystal imperfections: Point and line defects - Crystal Growth Techniques - Bridgman and Czochralski techniques (Qualitative). **Ultrasonics:** Introduction – Production – Magnetostriction and Piezoelectric Oscillator methods – Engineering and Medical applications – Sound Navigation and Ranging (SONAR), Non – Destructive Testing (NDT) and Sonogram.			
Unit – IV	**SEMICONDUCTING & MODERN ENGINEERING MATERIALS**	Periods	**9**
Intrinsic semiconductor – Carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – Electrical conductivity- Band gap determination (Qualitative) -Extrinsic semiconductors - Carrier concentration derivation in n – type and p – type semiconductor– Variation of Fermi level with temperature (Qualitative). **Metallic glasses:** preparation, properties and applications - Shape memory alloys (SMA): Characteristics and applications of NiTi alloy.			
Unit – V	**LASER AND FIBER OPTICS**	Periods	**9**
Laser: Characteristics of laser - Stimulated absorption, Spontaneous emission and Stimulated emission - Population inversion- Einstein's A and B coefficients – derivation. Types of laser - Nd-YAG laser - Semiconductor laser:Homo junction and Hetero junction (Qualitative) - Applications. **Optical fiber:** Principle of propagation of light through optical fiber - expressions for numerical aperture and acceptance angle -Types of optical fibers -Fiber optical.			
		Total Periods	**45**
Text Books			
1.	R.K. Gaur and Gupta. S.L, Engineering Physics, Dhanpat Rai Publishers, 2017.		
2.	S.O Pillai., Solid state physics, New Age International Private Limited.		
3.	Dr.P.Mani, "Engineering Physics", Shri Dhanam publisher, Chennai – 600 042.		

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References	
1.	B.K. Pandey, S. Chaturvedi. "Engineering Physics", 1st Edition, Cengage Learning India Pvt Ltd, (2012).
2.	Fundamentals Of Physics Extended 8/Ed 8th Edition, David Halliday, Robert ResnickJearl Walker, Wiley India Pvt Ltd, 2008.
3.	Lawrence H.Vanvlack, "Elements of materials Science Engineering, 6th Edition, Pearson Publication.
4.	S.O.Pillai, "Solid State Physics", New Age International Publishers .
5.	Dr.V.Rajendran, "Engineering Physics", Tata McGraw Hill Education Private Limited, New Delhi.
E-Resources	
1.	www.e-booksdirectory.com
2.	Home.iitk.ac.in
3.	physics.cu.ac.bd/

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Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**II**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EE201	**Basic Electrical and Electronics Engineering**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Learn the basic concepts of electrical parameters and electrical machines. • Learn the electrical wiring methods. • Learn the basics about semiconductor families and digital logics.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Understand the basics of electric circuits and type of the connection.	K2
	CO2: Understand the basics of electromagnetic laws and basic working principle of DC and AC machines.	K2
	CO3: Understand the concepts of tariff, energy saving, illumination, electric lamps and safety measures.	K2
	CO4: Understand the basic operating characteristics of semiconductor devices.	K2
	CO5: Understand the fundamentals of digital logics and integrated circuits.	K2
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2										3	3		2
CO 2	3	2										3	3		2
CO 3	3											3	3		3
CO 4	3	2										3	3		2
CO 5	3	2										3	3		2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION OF ELECTRICAL CIRCUITS**	Periods	**9**
Definition of Voltage, Current, Power, Energy, Power factor, Circuit parameters, Ohm"s law, Kirchoff"s law. Concepts of AC Circuits- RMS value, Average value, Form and Peak factors, Concept of real and reactive power. Introduction to three phase systems - types of connections, relationship between line and phase values. Concept of DC circuits.			
Unit - II	**INTRODUCTION OF ELECTRICAL MACHINES AND MEASUREMENTS**	Periods	**9**
Faraday's laws of electromagnetic induction - Lens law - Fleming's left hand rule and Right hand rule. Working principle and construction of AC and DC machines -Working principle and construction of Transformer- Introduction to electrical measuring instruments – Analog and Digital Instruments **(Qualitative).**			
Unit – III	**WIRING AND ILLUMINATION**	Periods	**9**
Types of wiring-staircase and corridor wiring - wiring accessories. Different types of safety measures - Earthing. Electrical tariff - Energy conservation. Simple layout of power system-various energy resources,. The Laws of Illumination - Different types of electrical lamps.			
Unit - IV	**SEMICONDUCTOR DEVICES**	Periods	**9**
PN junction diodes - Zener diodes - characteristics. Transistors: PNP and NPN transistors - Theory of operation - Transistor configurations -characteristics - comparison. Special semiconductor devices: FET - SCR - LED – V-I characteristics –UPS – SMPS.			
Unit – V	**DIGITAL FUNDAMENTALS**	Periods	**9**
Number systems - Boolean Theorems – De Morgan's Theorem - Logic gates -Implementation of Boolean Expression using Gates - Introduction to Operational Amplifier.			
		Total Periods	**45**
Text Books			
1.	D.P. Kotharti and I.J Nagarath, Basic Electrical and Electronics Engineering, Mc Graw Hill, Third Edition, 2016.		
2.	M.S. Sukhija and T.K. Nagsarkar, Basic Electrical and Electronics Engineering, Oxford, 2016.		
References			
1.	S.B. Lal Seksena and Kaustuv Dasgupta, Fundaments of Electrical Engineering, Cambridge, 2016.		
2.	Mittle,Mittal, Basic Electrical Engineeringl, 2nd Edition, Tata McGraw-Hill Edition, 2016.		
3.	S.K.Sahdev, Basic of Electrical Engineering, Pearson, 2015.		
4.	John Bird, —Electrical and Electronic Principles and Technology, Fourth Edition, Elsevier, 2010.		
5.	K Murugesh Kumar, Elements of Electrical Engineering, Vikas Publishing House Pvt. Ltd.2011.		
E-Resources			
1.	https://nptel.ac.in/courses		
2.	https://www.electrical4u.com/electrical-engineering-articles/illumination-engineering/		
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/lecture-notes		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**B.E**	Programme Code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**II**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19GE202	**Basic Civil and Mechanical Engineering**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Familiarize the materials and measurements used in Civil Engineering. • Provide the exposure on the fundamental elements of civil engineering components and structures. • Impart basic knowledge of power plants, pumps & boilers. • Study the various types of IC engines and understand the features of IC engine. • Enable the students to distinguish the components and working principle of refrigeration and air conditioning system.	
Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Explain the usage of civil engineering materials and measure the location of points in surveying.	K2
	CO2: Identify the nature of building components, structures and material qualities.	K1
	CO3: Classify the various types of power plant, pump, turbine & boiler.	K2
	CO4: Compare sparks ignition and compression ignition of two stroke and four stroke engine.	K2
	CO5: Elaborate the working principle of refrigeration and air conditioning system.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3	2	3	-	-	-	-	-	-	-	3	2	-
CO 2	3	3	3	2	3	-	-	-	-	-	-	-	2	-	-
CO 3	3	2	2	-	2	-	-	-	-	-	-	-	2	3	-
CO 4	3	3	2	-	2	-	-	-	-	-	-	-	2	-	-
CO 5	3	2	2	-	2	-	-	-	-	-	-	-	3	2	-

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**CIVIL ENGINEERING MATERIALS AND SURVEYING**	**Periods**	**9**

Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel sections.
Surveying: Objects – Types – Classification – Principles – Measurements of distances – Angles – Leveling – Determination of areas – Illustrative examples.

Unit - II	**BUILDING COMPONENTS AND STRUCTURES**	**Periods**	**9**

Foundations: Site selection, Foundation – Types – Requirement of good foundations.
Superstructure: Brick masonry – Stone masonry – Beams – Columns – Lintels – Roofing – Flooring - Plastering-Types of bridges and dams.

Unit - III	**POWER PLANT ENGINEERING**	**Periods**	**9**

Introduction, Classification of Power Plants – Boiler - Working principle of steam , Gas , Diesel , Hydro-electric, Solar, Wind and Nuclear Power plants – Merits and Demerits – Pumps and turbines – Working principle of reciprocating pumps (single acting and double acting) – Centrifugal Pump.

Unit - IV	**IC ENGINES**	**Periods**	**9**

Internal combustion engines as automotive power plant – Four stroke and two stroke cycles – Working of SI and CI engines - Comparison of four stroke and two stroke engines.

Unit - V	**REFRIGERATION AND AIR CONDITIONING SYSTEM**	**Periods**	**9**

Terminology of refrigeration and air conditioning. Principle of vapour compression and vapour absorption refrigeration system – Layout of typical domestic refrigerator – Window and split type room air conditioner.

	Total Periods	**45**

Text Books

1.	Dr.P.Kannan, "Basic Mechanical Engineering", JBR Tri Sea Publishers Pvt. Ltd., 2019.
2.	Pravin Kumar, "Basic Mechanical Engineering", Pearson Publishers, New Delhi, 2013.

References

1.	Dr.S.Ramachandaran, " Basic Civil and Mechanical Engineering " Air Walk Publication,2016.
2.	R.Gupta, "Basic Civil Engineering", RPH Publication, 2016.
3.	Mrs.V.Valarmathi, Mr.K.Rajasekar & Mr.T.Satheeskumar,"Basic Civil Engineering", JBR Tri Sea Publishers Pvt. Ltd., 2017.
4.	G.Shanmugam and M.S Palanichamy, "Basic Civil and Mechanical Engineering ",Tata McGraw Hill Publishing Company Limited, New Delhi,2014.
5.	S.Seetharaman, " Basic Civil Engineering ",Anuradha Agencies,2005.

E-Resources

1.	https://nptel.ac.in/downloads/105105104/
2.	https://nptel.ac.in/courses/112107216/
3.	http://link.springer.com/ "Basic Civil and Mechanical Engineering"-Springer Nature.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**II**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC201	**Electric Circuit Theory**	3	0	0	3	50	50	100
Course Objective	The students should made • To introduce electric circuits and its analysis. • Impart knowledge on solving circuits using network theorems. • Learn the phenomenon of resonance and coupled circuits. • Learn the transient response of circuits for various inputs. • Learn about two port networks and its parameters.							
Course Outcome	At the end of the course, the student should be able to,					Knowledge Level		
	CO1: Understand the basic laws, mesh current, nodal voltage methods for solving circuit problems.					K2		
	CO2: Understand the basic network theorems and its applications to solving networks for both DC and AC inputs.					K2		
	CO3: Understand the concepts of series & parallel resonance and coupled circuits.					K2		
	CO4: Understand the concepts of Circuit Transients for different inputs.					K2		
	CO5: Understand the two-port networks, parameters and its interconnections.					K2		
Pre-requisites	Basic concepts of physics, particularly about Electricity and Magnetism.							

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**												**CO/PSO Mapping**		
COs	Programme Outcomes (POs)											PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2										3	3		2
CO 2	3	2										3	3		2
CO 3	3											3	3		3
CO 4	3	2										3	3		2
CO 5	3	2										3	3		2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Quiz 3. End-Semester examinations
Indirect
1. Course - end Survey

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Content of the Course			
Unit – I	**BASIC CIRCUITS ANALYSIS**	Periods	**9**
Fundamental concepts of DC circuits, Ohm's Law and Kirchoff's law-Series and Parallel circuits - Loop and Nodal analysis, A.C circuits - Complex impedance - Phasor diagram, Real and Reactive power .Loop and Nodal analysis for AC circuits. Network Topology-Graph-Tree Link and Co-tree-Network variables-Incidence Matrix-Tie-set-Cut set-Duality.			
Unit - II	**NETWORK THEOREMS**	Periods	**9**
Voltage source –Current source transformations, Network Theorems -Superposition Theorems – Thevenin's and Norton's Theorem – Maximum Power Transfer Theorem – Reciprocity Theorem-Applications to DC and AC circuits, Star-Delta transformations.			
Unit – III	**RESONANCE AND COUPLED CIRCUITS**	Periods	**9**
Resonance in Series and Parallel Circuits, Self and Mutual Inductances, Quality factor and Bandwidth, Coefficient of coupling – Dot convention - Analysis of coupled circuits. Single Tuned and Double tuned Coupled Circuits.			
Unit - IV	**TRANSIENT ANALYSIS OF DC AND AC CIRCUITS**	Periods	**9**
Natural and Forced response ,Transient response of RL, RC and RLC Circuits using Laplace transform for DC, Step, Impulse inputs. and A.C. Sinusoidal input.			
Unit – V	**TWO PORT NETWORKS**	Periods	**9**
Two Port Networks, Characterization of LTI two port Networks- Impedance parameters- Admittance parameters, Transmission parameters and Hybrid parameters, Relationship between two port parameters, interconnections of Two port networks.			
		Total Periods	**45**
Text Books			
1.	William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 6th edition, New Delhi, 2003.		
2.	Charles K. Alexander, Matthew N. O. Sadiku, 'Fundamentals of Electric Circuits', McGraw-Hill Publications, 3rd Edition, 2007.		
3.	D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.		
References			
1.	Joseph. A. Edminister, 'Electric Circuits - Schaum's outline series', McGraw Hill Publications, 6th Edition, 2003.		
2.	Robins & Miller, 'Circuit Analysis Theory and Practice', Delmar Publishers, 5th Edition, 2012.		
E-Resources			
1.	https://nptel.ac.in/courses/117106108/		
2.	http://www.ee.iitm.ac.in/videolectures/doku.php?id=ec1010_2014nk:start		
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/lecture-notes		

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Programme	**B.E**	Programme Code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**II**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19PH208	**Physics Laboratory**	0	0	4	2	50	50	100
Course Objective	• To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.							
Pre-requisites	-							

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3		3									3	1		2
CO 2	3	3	1									3			3
CO 3	3	2	2									3			3
CO 4	3	3	2									3			3
CO 5	3		1									3			1

Course Assessment Methods

Direct
1.Pre lab and post lab test 2.End-Semester examinations
Indirect
1. Course - end survey

SUGGESTED LIST OF EXPERIMENTS

1. Determination of Young's modulus of the material - Uniform bending method.
2. Determination of Young's modulus of the material - Non uniform bending method.
3. Determination of Rigidity modulus – Torsion pendulum.
4. Determination of Coefficient of viscosity of a liquid – Poiseuille's method.
5. Determination of thickness of a thin material – Air wedge method.
6. Determination of wavelength of mercury spectrum – spectrometer grating.
7. Determination of Dispersive power of a prism – Spectrometer.
8. Determination of thermal conductivity of metallic glass using Lee's Disc Method.
9. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
10. Determination of Wavelength and particle size using Laser.

Total Periods	**45**

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Lab Manual	
1.	R. Jayaraman, Engineering Physics Laboratory Manual ,Pearson Pub,Edition-2018.
2.	A.K. Katiyar & C.K. Pandey Engineering Physics: Theory and Practical,Wiley Pub,2 nd Edition.

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Programme	**B.E**	Programme Code	**106**		Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**				Semester	**II**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19GE203	**Engineering Practices Laboratory**	0	0	4	2	50	50	100

Course Objective	The Main Objective of this course is to • Know the plumbing line assemblies. • Weld lap joint, butt joint and T-joint. • Learn the assembling and dismantling methodology of home appliances. • Learn the resistor value identification through colors coated on resistor. • Learn the basics of signal generation in CRO. • Learn the soldering techniques in PCB board for designing the projects.	
Course Outcomes	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Perform basic machining operations and finish the job to the requirements and quantify the accuracy.	K2
	CO2: Make various joints such as cross lap joint and Tee lap joint in the carpentry.	K2
	CO3: Understand the basics of house wiring techniques and the measurements of basic electrical quantities.	K2
	CO4: Understand the resistor value identification through colors coated on resistor.	K2
	CO5: Understand the soldering techniques in PCB board for designing the projects.	K2
Pre - requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2	3	2	2	-	-	-	2	-	-	-	2	3	-
CO 2	3	2	3	2	2	-	-	-	2	-	-	-	2	-	-
CO 3	3	2	2	3	2	2	-	-	2	-	-	-	2	-	-
CO 4	3	2	2	3	2	2	-	-	2	-	-	-	2	3	-
CO 5	3	2	3	3	2	2	-	-	2	-	-	-	2	-	-

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Course Assessment Methods

Direct
1. Pre lab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

Content of the Syllabus

GROUP A
(CIVIL & MECHANICAL ENGINEERING)

I. CIVIL ENGINEERING PRACTICE

1.Plumbing :

(a)Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers and elbows in household fittings.

(b)Hands-on-exercise:Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

2.Carpentry:

(a)Study of the joints in roofs, doors, windows and furniture.

(b)Hands-on-exercise: Wood work, joints by sawing, planning and cutting.

II. MECHANICAL ENGINEERING PRACTICE

1.Welding:

(a)Preparation of arc welding of butt joints, lap joints and tee joints.

(b)Gas welding practice

2.Basic Machining:

(a)Turning and Facing.

(b)Drilling Practice

3.Sheet Metal Work:

(a) Forming & Bending

(b) Model making – Tray and Basket.

4.Demonstration on:

(a) Foundry operations like mould preparation for gear and step cone pulley.

(b) Fitting – Exercises – Preparation of square fitting and vee – fitting models.

5. Study of Air Conditioner & Centrifugal Pump.

GROUP B
(ELECTRICAL & ELECTRONICS ENGINEERING)

III. ELECTRICAL ENGINEERING PRACTICE

1.Residential house wiring using switches, fuse, indicator, lamp and energy meter.

2.Fluorescent lamp wiring.

3.Stair case wiring.

4.Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.

5.Measurement of energy using single phase energy meter.

6.Measurement of resistance to earth of electrical equipment.

7.Demonstration on Soldering & Brazing.

8.Hands on exercises/assembly of Computer, Laptop, Cell phone, Fan, Iron box etc.

IV. ELECTRONICS ENGINEERING PRACTICE

1.Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, RMS period, frequency) using CR.

2.Study of logic gates AND, OR, EOR and NOT.

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3.Generation of Clock Signal. 4.Soldering practice – Components Devices and Circuits – Using general purpose PCB. 5.Measurement of ripple factor of HWR and FWR.	
Total Periods	**45**
Reference Book :	
1.	Dr.P.Kannan, Mr.T.Satheeskumar & Mr.K.Rajasekar, "Engineering Practices Laboratory" Manual. First Edition, 2017.
2.	Mr.T.Jeyapoovan, Mr.M.Saravana Pandian, "Engineering Practices Lab" Manual, Vikas Publishing House Pvt Ltd, 2017.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**II**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCFY1	**Environmental Science and Engineering**	3	0	0	0	100	0	100

Course Objective	The students should be made to • Familiarize basics of ecosystem and creating environmental awareness. • Congregate quality and standards requirement of water. • Contrast water management procedures. • Acquire knowledge on air pollution and its control. • Summarize Solid waste and its prevention methods.	
Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Distinguish the types of Ecosystem and implicit the knowledge.	K2
	CO2: Recognize quality, standard and control strategies of polluted water.	K2
	CO3: Infer and express air pollution and its control.	K2
	CO4: Acquire Knowledge about Radioactive pollution and disposal method.	K2
	CO5: Awaraness about population growth, human rights and Environment.	K2
Pre-requisites	Basic concepts of physics, particularly about Electricity and Magnetism.	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	1	1			2	3				1	2			
CO 2	1	2	2			2	3					3			
CO 3	2	2	1			3	3				1	2			
CO 4	1	1	1			2	3				1	2	2		
CO 5	1	2	1			2	2				1	3	2		

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment and Quiz 3. End-Semester examinations
Indirect
1. Course - end Survey

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Content of the Course			
Unit – I	**Introduction to Environmental Science and Engineering**	Periods	**9**
Nature and scope of environmental education- Natural Resources – (Forest, Water, Food, Energy &Land Resources) problems, Ecosystem and Biodiversity- Ecosystem-Structure, Characteristics and functions of ecosystem (in general)- Biodiversity – Definition – Conservation of Biodiversity (in-situ and Ex-situ)- Environmental awareness and sustainable development.			
Unit – II	**Water pollution and Waste water treatment process**	Periods	**9**
Water pollution-causes, effects and control measures of water pollution- case study- Waster water 72eparator process-Water quality parameters- Haredness, Alkalinity, DO, COD, BOD-Water quality standard- WHO and BIS- Treatment Process- RO, Ion exchange and Zeolite process.			
Unit – III	**Air Pollution and its Control**	Periods	**9**
Air pollutants- causes, effects (Acid rain, Green house effect, Ozone layer depletion and global warming)- control measures (Electro static precipitator and cyclone separator).			
Unit – IV	**Radioactive Pollution and Solid waste management**	Periods	**9**
Radio active pollutants-sources, effects and control measures-Nuclear power plant- impacts- case study- solid waste-defenition-Types of solid waste- Disposal method and its problem in solid waste management.			
Unit – V	**Human population and the environment**	Periods	**9**
Population growth, Human rights, Value education, environment and Human health, Family welfare Program, role of information technology in environment and Human health.			
		Total Periods	**45**
Text Books			
1.	Dr.S. Vairam, "Environment Science and Engineering" Gems publication. Edition 2018		
2.	Gilbert.M.Masters-"Environmental Science"-Pearson education. Edition-2-2013		
References			
1.	Linda Williams- "Environmental Science"-Tata McGRAW – Hill Edition. Edition-I-2008.		
2.	T.G.Miller Jr-"Environmental Science"-Wadsworth publishing Co. Edition -10-2004.		
3.	William P. Cunningham, Barbara Woodworth Saigo- Tata McGraw Hill.Edition-4-2011.		
4.	NPTEL Course Notes.		
5.	Cunnighum and cooper-"Environmental Science"-Jaico Publ, House Edition-4-2007.		
E-Resources			
1.	https://libraries.ou.edu/		
2.	https://libguides.reading.ac.uk/		
3.	https://libguides.reading.ac.uk/		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**III**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MA303	**Transforms and Partial Differential Equations**	3	1	0	4	50	50	100

Course Objective	The students should be made to • Introduce the basic concepts of PDE for solving standard partial differential equations. • Solve boundary value problems by using Fourier series. • Acquaint the student with Fourier series techniques in solving heat flow problems used in various situations. • Acquaint the student with Fourier transform techniques used in wide variety of situations. • Introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.	
Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Understand how to solve the given standard partial differential equations.	K2,K4
	CO2: Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.	K3,K4
	CO3: Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	K3,K5
	CO4: Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.	K2,K5
	CO5: Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	K1,K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3										3	2	
CO 2	3				2								3	3	
CO 3	3		2										3	2	
CO 4	3	3											3	2	
CO 5	3				2								3	3	

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**FOURIER SERIES**	Periods	**12**
Dirichlet's conditions – General Fourier series – Change of interval – Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.			
Unit – II	**PARTIAL DIFFERENTIAL EQUATIONS**	Periods	**12**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Singular integral - Solution of Standard types of first order partial differential equations -Lagrange's linear equation – Solution of homogeneous linear partial differential equations of higher order with constant coefficients.			
Unit – III	**APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**	Periods	**12**
Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).			
Unit – IV	**FOURIER TRANSFORM**	Periods	**12**
Fourier Integral theorem (without proof) – Fourier transform pair – Properties (without proof) – Transforms of simple functions – Fourier Sine and Cosine transforms – Properties (without proof) – Convolution theorem and Parseval's identity (Statement and applications only).			
Unit – V	**Z –TRANSFORM**	Periods	**12**
Definition – Z-transform of some basic functions – Elementary properties – Inverse Z-transform: Partial fraction method – Residue method –Initial and Final value theorem- Convolution theorem – Applications of Z-transforms: Solution of difference equations.			
		Total Periods	**60**

Text Books

1.	Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2.	Churchill, R.V. and Brown, J. W., Fourier series and boundary value problems.(8th Edition), McGraw-Hill, 2011.

References

1.	Veerarajan T, Engineering Mathematics, McGraw Hill Education, 2013.
2.	Kreyszig, E., Advanced Engineering Mathematics (10th Edition), John Wiley (2015).
3.	Ramana.B.V., "Higher Engineering Mathematics" , Tata Mc Graw Hill Publishing Company Limited, New Delhi, 2008.
4.	P.R.Vittal, "Differential equations Fourier and Laplce Transforms", Margham Publishers, 2nd Edition, 1999.
5.	Ray Wylie. C and Barrett.C, " Advanced Engineering Mathematics " Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition ,New Delhi 2012.

E-Resources

1.	https://learnengineering.in
2.	www.learnerstv.com/Free-engineering-Video-lectures
3.	www.nptel.ac.in

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**III**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM301	**Anatomy and Human Physiology**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Identify all the organelles of an animal cell and their function. • Understand structure and functions of the skeletal, muscular and respiratory systems of human body. • Understand structure and functions of the cardiovascular and lymphatic systems of human body. • Understand structure and functions of the nervous and endocrine systems and sense organs of human body. • Demonstrate their knowledge of importance of anatomical features and physiology of human systems.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Explain basic structure and functions of cell.	K2
	CO2: Understand structure and functions of the skeletal, muscular and respiratory systems of human body.	K2
	CO3: Understand structure and functions of the cardiovascular and lymphatic systems of human body.	K2
	CO4: Understand structure and functions of the nervous and endocrine systems and sense organs of human body.	K2
	CO5: Demonstrate their knowledge of importance of anatomical features and physiology of human systems.	K2
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	1	2	3	1	1	2	1	2	1	1	1	1	3	1	2
CO 2	1	1	3	2	1	1	1	2	1		1	1	2	2	2
CO 3	1	2	1	1	2	1	1	2	1	1	1	1	3	2	2
CO 4	1	1	2	3	1	1	2	2	1	1	1	1	1	3	2
CO 5	3	1	2	3	1	1	1	2	1	1	1	1	2	3	1

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**CELL AND TISSUE STRUCTURE**	Periods	**9**
Structure of Cell – structure and functions of sub organelles – Cell Membrane –Transport of Across Cell Membrane - Action Potential – Cell to Cell Signaling – Cell Division. Types of Specialized tissues – Functions.			
Unit - II	**SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS**	Periods	**9**
Skeletal::Types of Bone and function – Physiology of Bone formation – Division of Skeleton – Types of joints and function – Types of cartilage and function. Muscular: Parts of Muscle – Movements. Respiratory: Parts of Respiratory Systems – Types of respiration - Mechanisms of Breathing – Regulation of Respiration.			
Unit – III	**CARDIOVASCULAR AND LYMPHATIC SYSTEMS**	Periods	**9**
Cardiovascular: Components of Blood and functions.- Blood Groups and importance – Structure of Heart – Conducting System of Heart – Properties of Cardiac Muscle - Cardiac Cycle - Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure. Lymphatic: Parts and Functions of Lymphatic systems – Types of Lymphatic organs and vessels.			
Unit - IV	**NERVOUS AND ENDOCRINE SYSTEMS AND SENSE ORGANS**	Periods	**9**
Nervous: Cells of Nervous systems – Types of Neuron and Synapses – Mechanisms of Nerve impulse – Brain : Parts of Brain – Spinal Cord – Tract and Pathways of Spines – Reflex Mechanism – Classification of Nerves - Autonomic Nervous systems and its functions. Endocrine - Pituitary and thyroid gland, Sense Organs: Eye and Ear.			
Unit – V	**DIGESTIVE AND URINARY SYSTEMS**	Periods	**9**
Digestive: Organs of Digestive system – Digestion and Absorption. Urinary: Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulation of Blood pressure by Urinary System – Urinary reflex, Regulation of human body temperature through Urinary System.			
		Total Periods	**45**

Text Books

1.	Prabhjot Kaur. "Text Book of Anatomy and Physiology". Lotus Publsihers. 2014.
2.	Elaine.N. Marieb , "Essential of Human Anatomy and Physiology", Eight Edition, Pearson Education, New Delhi, 2007.

References

1.	Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, "Fundamentals of Anatomy and Physiology" Pearson Publishers, 2014.
2.	Gillian Pocock, Christopher D. Richards, "The human Body – An introduction for Biomedical and Health Sciences", Oxford University Press, USA, 2013.
3.	William F.Ganong, "Review of Medical Physiology", 22nd Edition, Mc Graw Hill, New Delhi, 2010.
4.	Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, 2015
5.	Guyton & Hall, "Medical Physiology", 13th Edition, Elsevier Saunders, 2015.

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E-Resources	
1.	https://www.science.gov/topicpages/e/e-learning+human+anatomy
2.	https://oer.galileo.usg.edu/cgi/viewcontent.cgi?article=1004&context=biology-collections
3.	https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/nursing_students/LN_human_anat_final.pdf

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**		Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**				Semester	**III**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM302	**Bio Sensors and Measurement Devices**	3	0	0	3	50	50	100

Course Objective	The student should be made to • Understand the purpose of measurement, the methods of measurements, errors associated with measurements. • Know the principle of transduction, classifications and the characteristics of different transducers. • Demonstrate the various sensors used in medical diagnosis. • Know the different bridges for measurement. • Know the different display and recording devices.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Measure various electrical parameters with accuracy, precision, resolution.	K2
	CO2: Select appropriate passive or active transducers for measurement of physical phenomenon.	K1
	CO3: Select appropriate light sensors for measurement of physical and physiological phenomenon.	K1
	CO4: Use AC and DC bridges for relevant parameter measurement.	K3
	CO5: Employ Multimeter, CRO and different types of recorders for appropriate measurement.	K3
Pre-requisites	Physics	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**													**CO/PSO Mapping**		
Cos	Programme Outcomes (POs)												PSOs		
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	1									1		
CO 2	3	3	2	1									1		
CO 3	3	3	2	1									1		
CO 4	3	3	3	2									1		
CO 5	3	3	3	2									1		

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**SCIENCE OF MEASUREMENT**	Periods	**9**
Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis – Calibration - Primary and secondary standards.			
Unit - II	**ACTIVE AND PASSIVE TRANSDUCERS**	Periods	**9**
Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gage. Capacitive transducer - various arrangements, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Active type: Thermocouple – characteristics, Skin temperature measurement.			
Unit – III	**PHOTOELECTRIC, PIEZO ELECTRIC AND RADIATION SENSORS**	Periods	**9**
Radiation detectors: Gas filled, Geiger-Muller counter and scintillation counter. Phototube, photo multiplier tube (PMT), photovoltaic, photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers. Optical displacement sensors, optical encoders and Optical biosensors for measurement of blood glucose level. Piezoelectric active transducer- Equivalent circuit and its characteristics.			
Unit - IV	**SIGNAL CONDITIONING CIRCUITS**	Periods	**9**
Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering.			
Unit – V	**DISPLAY AND RECORDING DEVICES**	Periods	**9**
Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder.			
		Total Periods	**45**

Text Books

1.	A.K.Sawhney, —Electrical & Electronics Measurement and Instrumentation‖,10th edition, DhanpatRai& Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2.	John G. Webster, —Medical Instrumentation Application and Design‖, 4th edition, Wiley India Pvt Ltd,New Delhi, 2015.

References

1.	Ernest O Doebelin and Dhanesh N Manik, Measurement systems, Application and design, 6th edition, McGraw-Hill, 2012.
2.	Khandpur R.S, —Handbook of Biomedical Instrumentation‖, 3rdedition,Tata McGraw-Hill, New Delhi, 2014.
3.	Leslie Cromwell, —Biomedical Instrumentation and measurement‖, 2nd edition, Prentice hall of India, New Delhi, 2015.
4.	Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques‖, Prentice Hall of India, 1stedition, 2016.

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E-Resources	
1.	https://www.intechopen.com/books/advances-in-bioengineering/biomedical-sensor-device
2.	https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**III**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BM303	**Fundamentals of Bio Chemistry**	3	0	0	3	50	50	100

Course Objective	The student should be made to • Understand the fundamentals of biochemistry. • Know the structural and functional properties of carbohydrates. • Know the structural and functional properties of proteins. • Know the structural and functional properties of lipids and nucleic acids. • Emphasize the role of these biomolecules by providing basic information on specific metabolic diseases and disorders of these biomolecules.	
Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Explain the fundamentals of biochemistry.	K2
	CO2: Explain the structural and functional properties of carbohydrates.	K2
	CO3: Explain the structural and functional properties of proteins.	K2
	CO4: Explain the structural and functional properties of lipids and nucleic acids.	K2
	CO5: Employ Clinical application of Biochemistry.	K3
Pre-requisites	Chemistry	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	1					1						3		3
CO 2	3	1					1						3		3
CO 3	3	1					1						3		3
CO 4	3	1					1						3		3
CO 5	3	1					1						3		3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION TO BIOCHEMISTRY**	Periods	**9**
Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson - Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes.			
Unit – II	**CARBOHYDRATES**	Periods	**9**
Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates Isomerism, racemisation and mutarotation. Digestion and absorption of carbohydrates. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain. Oxidative phosphorylation. Biochemical aspect of Diabetes mellitus and Glycogen storage Disease.			
Unit – III	**LIPIDS**	Periods	**9**
Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat..Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, Biosynthesis of Cholesterol. Disorders of lipid metabolism.Good and Bad Cholesterol.			
Unit – IV	**NUCLEIC ACID & PROTEIN**	Periods	**9**
Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as a genetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Metabolism and Disorder of purines and pyrimidines nucleotide Classification, structure and properties of proteins, structural organization of proteins, classification and properties of amino acids. Separation of protein, Inborn Metabolic error of amino acid metabolism.			
Unit – V	**ENZYME AND ITS CLINICAL APPLICATION**	Periods	**9**
Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes - Michaelis-Menten equation.Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non- competitive, irreversible. Enzyme: Mode of action, allosteric and covalent regulation. Clinical enzymology. Measurement of enzyme activity and interpretation of units.			
		Total Periods	**45**

Text Books	
1.	RAFI MD —Text book of biochemistry for Medical Student‖ Second Edition, University Press, 2014.
2.	David.W.Martin, Peter.A.Mayes , Victor. W.Rodwell, —Harper's Review of Biochemistry‖, LANGE Medical Publications, 1981.
References	
1.	Keith Wilson & John Walker, —Practical Biochemistry - Principles & Techniques‖, Oxford University Press, 2009.
2.	Pamela.C.Champe & Richard.A.Harvey, —Lippincott Biochemistry Lippincott's Illustrated Reviews‖, Raven publishers,1994.
E-Resources	
1.	https://libguides.library.usyd.edu.au/c.php?g=508174&p=3476667
2.	https://guides.library.ucla.edu/c.php?g=180262&p=1187117
3.	https://libraries.ou.edu/subjects/chemistry-biochemistry

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**III**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC315	**Digital System Design**	3	0	0	3	50	50	100

Course Objective

The student should be made to,

- Cram about basic postulates of Boolean algebra and simplification of Boolean expressions to deduce optimal digital Circuits.
- Gain the knowledge of Karnaugh Map Minimization procedures for the analysis and design of combinational circuits and sequential circuits.
- Implant the functions and extremity of Sequential Circuits in digital design.
- Evaluate the general notion of asynchronous sequential circuits.
- Inculcate the concept of memories and programmable logic devices.

Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Analyze the Boolean Functions and Boolean Expressions.	K4
	CO2: Design the Combinational Circuits using Logic Gates.	K3
	CO3: Design the Synchronous Sequential Circuits using Flip Flops..	K3
	CO4: Analyze the Asynchronous Sequential Circuits and design Combination and Sequential Circuits using VERILOG.	K4
	CO5: Apprehend the Characteristics and structure of different memory systems and Programmable Logic devices.	K3
Pre-requisites	-	

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2	2	2	2							3	3		2
CO 2	3	3	3	2	2							3	3		2
CO 3	3	3	3	2	2							3	3		2
CO 4	3	3	3	2	2							3	3		2
CO 5	3	2	2		2							3	2		2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Case studies, Real time Applications. 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**MINIMIZATION TECHNIQUES AND LOGIC GATES**	Periods	**9**
Number Systems - Boolean Postulates and Laws – De-Morgan's Theorem – Principle of Duality – Boolean Expression – Minimization of Boolean Expression - Sum of Products(SOP) – Product of sums(POS) – Karnaugh Map Minimization – Don't Care Conditions – Quine McClusky Method of Minimization. Logic Gates (AND , OR , NOT , NAND , NOR , Exclusive – OR and Exclusive – NOR) – Implementation of Logic Function Using Gates , NAND – NOR Implementations.			
Unit – II	**DESIGN OF COMBINATIONAL CIRCUITS**	Periods	**9**
Design Procedure –Design of Adder, Subtractor, Binary Multiplier, Muliplexer /Demultiplexer, Decoder, Encoder, Parity Checker, Parity Generators, Code Converters, Magnitude Comparator.			
Unit – III	**SYNCHRONOUS SEQUENTIAL CIRCUITS**	Periods	**9**
Sequential Logic Elements-Latches, Flip-Flops, Registers, Counters, State Diagram -State Table – State Minimization - State Assignment – Excitation Table and Maps – Design and Analysis of Synchronous Sequential Circuits.			
Unit – IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS**	Periods	**9**
Design of Fundamental Mode and Pulse Mode Circuits – Incompletely Specified State Machine – Problems in Asynchronous Circuits – Design of Hazard Free Switching Circuits. Design of Combinational and Sequential circuits using VERILOG.			
Unit – V	**MEMORIES AND PROGRAMMABLE LOGIC DEVICES**	Periods	**9**
Classification of Memories – ROM – ROM Organization – PROM - EPROM – EEPROM , RAM – RAM Organization – Write Operation –Read Operation – Memory Cycle – Timing Wave Forms – Memory Decoding – Memory Expansion – Static and Dynamic RAM– Programmable Logic Devices – Programmable Logic Array(PLA) – Programmable Array Logic (PAL) – Field Programmable Gate Arrays(FPGA) – Implementation of Combinational Logic Circuits Using ROM, PLA, PAL.			
		Total Periods	**45**
Text Books			
1.	M. Morris Mano, Digital Design, 3rd Edition, Prentice Hall of India Pvt. Ltd., 2003 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.		
2.	John F.Wakerly, Digital Design, Fourth Edition, Pearson/PHI, 2006.		
References			
1.	John.M Yarbrough, Digital Logic Applications and Design, Thomson Learning, 2002.		
2.	Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 2004.		
3.	William H. Gothmann, Digital Electronics, 2nd Edition, PHI, 1982.		
4.	Thomas L. Floyd, Digital Fundamentals, 8th Edition, Pearson Education Inc, New Delhi, 2005.		
5.	Donald D. Givone, Digital Principles and Design, TMH, 2016.		
E-Resources			
1.	https://libguides.library.usyd.edu.au/c.php?g=508174&p=3476667		
2.	https://guides.library.ucla.edu/c.php?g=180262&p=1187117		
3.	https://libraries.ou.edu/subjects/chemistry-biochemistry		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**B.E.**	Programme code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**III**		
Course code	Course Name	Periods /Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19EC316	**Electron Devices and Circuits**	3	0	0	3	50	50	100

Course Objective

The students should be made to

- Deliver the knowledge about basics of semiconductor devices.
- Enhance commanding skillfulness of students through understanding of electronic devices.
- Introduce and motivate students to use the advanced microelectronic devices.
- Describes the foundation for forthcoming circuit design courses.
- Gain knowledge about the technological importance of forthcoming circuit design.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Explain the structure and working operation of basic electronic devices.	K2
CO2: Identify and differentiate both active and passive elements.	K3
CO3: Analyze the characteristics of different electronic devices such as diodes and Transistors.	K4
CO4: Choose and adapt the required components to construct an amplifier circuit.	K5
CO5: Employ the acquired knowledge in design and analysis of oscillators.	K4

Pre-requisites U19EE201 - Basic Electrical and Electronics Engineering

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3											3		2
CO 2	3	3	2	2									3		2
CO 3	3	3	2	2									3		2
CO 4	3	3	2	2									3		2
CO 5	3	3	3	3									3		2

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment: Case Studies, Real Time Applications
3. End-Semester examinations

Indirect

1. Course - end survey

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Content of the syllabus			
Unit – I	**PN JUNCTION DEVICES**	Periods	**9**
PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier,– Display devices- LED, Laser diodes, Zener diodecharacteristics- Zener Reverse characteristics – Zener as regulator			
Unit – II	**TRANSISTORS AND THYRISTORS**	Periods	**9**
BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristors and IGBT - Structure and characteristics.			
Unit – III	**AMPLIFIERS**	Periods	**9**
BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.			
Unit – IV	**MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER**	Periods	**9**
BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis).			
Unit – V	**FEEDBACK AMPLIFIERS AND OSCILLATORS**	Periods	**9**
Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.			
	Total Periods		**45**

Text Books:	
1.	Sedra and smith, —Microelectronic circuits‖,7th Ed., Oxford University Press.
2.	David Bell, "Electronic Devices and Circuits", Oxford, Fifth Edition,2008.
References:	
1.	Balbir Kumar, Shail.B.Jain, —Electronic devices and circuits‖ PHI learning private limited, 2nd edition 2014.
2.	Thomas L.Floyd, —Electronic devices‖ Conventional current version, Pearson prentice hall, 10th Edition, 2017.
3.	Donald A Neamen, —Electronic Circuit Analysis and Design‖ Tata McGraw Hill, 3rd Edition, 2003.
4.	Robert L.Boylestad, —Electronic Devices and Circuit Theory‖, 2002.
5.	Robert B. Northrop, —Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation‖, CRC Press, 2004.
E-Resources:	
1.	https://www.electronics-tutorials.ws/diode/diode
2.	https://nptel.ac.in/courses/117102061/
3.	https://www.sciencedirect.com/topics/physics-and-astronomy/optical-device

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
(Autonomous Institution, Affiliated to Anna University ,Chennai)
Elayampalayam, Tiruchengode – 637 205

Programme	B.E.	Programme Code	106	Regulation	2019
Department	BIOMEDICAL ENGINEERING			Semester	III

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM304	Bio Sensors And Measurements Laboratory	0	0	2	1	50	50	100

Course Objective

The student should be made to,

- Study the characteristics of sensors, signal conditioning circuits and their biomedical applications.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: To design measurement system for various biomedical applications.	K4
CO2: Identification and enumeration of pulse rate.	K4
CO3: Have a sound knowledge of Respiratory measurement system.	K2
CO4: Enumeration of various electronic components using bride circuits.	K3
CO5: Analysis of temperature, load and photo electric parameters.	K4

Pre-requisites

-

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	1	2					1	2			2		
CO 2	3	2	1	1					1	2			2		
CO 3	3	2	1	1					1	2			2		
CO 4	3	2	1	2					1	2	1		2		
CO 5	3	2	1	1					1	2	1		2		

Course Assessment Methods

Direct
1. Prelab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus

SUGGESTED LIST OF EXPERIMENTS:

1. Measurement of skin temperature – contact and non-contact method.
2. Characteristics of thermistor.
3. Characteristics of thermocouple.
4. Characteristics of Photo Diode.
5. Characteristics of Photo transistor.
6. Characteristics of RTD.
7. Characteristics of LVDT.
8. Measurement of SpO2.
9. Measurement of unknown Resistance using Kelvin Double Bridge and Wheatstone bridge.
10. Measurement of unknown Capacitance using Schering Bridge.
11. Measurement of unknown Inductance using Maxwell's & Hay's Bridge.
12. Measurement of respiration rate.
13. Measurement of glucose level in Blood.

Total Periods	**45**

Suggested Lab Manuals:

1.	Maria Teresa, Restivo Fernando, Gomes de Almeida, Maria de Fátima, Chouzal Joaquim, Gabriel Mendes António Mendes Lopese-book on "Laboratories of Instrumentation for Measurement"

E-Resources

1.	https://www.elsevier.com/books/principles-of-electronic-instrumentation/de-sa/978-0-08-093469-3
2.	https://www.ifm.liu.se/courses
3.	https://www.sciencedirect.com/topics/physics-and-astronomy

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**III**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM305	**Bio Chemistry and Human Physiology Laboratory**	0	0	2	1	50	50	100

Course Objective

The student should be made to,

- Learn the Estimation and quantification of biomolecules.
- Learn Separation of macromolecules.
- Learn estimation and quantification of blood cells.
- Learn estimation of hematological parameters.
- Learn the analysis of visual and hearing test.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Understand the Biochemistry laboratory functional components.	K6
	CO2: Understand the basics principle of preparation of buffers.	K2
	CO3: Identification and enumeration of blood cells.	K6
	CO4: Enumeration of hematological parameters.	K2
	CO5: Have a sound knowledge of bleeding and clotting time.	K3

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	1	1	1	2	2	1	1	2	2	1	3	2	3	3	2
CO 2	1	1	1	2	1	1	1	2	2	1	3	3	3	2	2
CO 3	1	1	2	3	1				3	2	1	2			1
CO 4	2	2	3	2	3	1	2		3	3	3	2	3	2	3
CO 5	1	1	1	2	1				3	3	3	3			

Course Assessment Methods

Direct
1. Prelab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus

SUGGESTED LIST OF EXPERIMENTS:

Bio Chemistry

1. General guidelines for working and functional component of biochemistry lab.
2. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions.
3. Standardization of pH meter, preparation of buffers, emulsions.
4. Spectroscopy: Determination of absorption maxima (λ max) of a given solution.
5. General tests for carbohydrates, proteins and lipids.
6. Identification of Blood Collection Tubes and Phlebotomy equipments.
7. Preparation of serum and plasma from blood.
8. Estimation of Hemoglobin.
9. Estimation of urea and Uric acid.
10. Separation of proteins by SDS electrophoresis(Demo).
11. Collection of Blood Samples and Identification of Blood groups.
12. Bleeding and Clotting time.
13. Estimation of ESR.
14. Hearing Test – Tuning Fork.
15. Visual Activity – Snellen's Chart and Jaeger's Chart.

Total Periods	**45**

Suggested Lab Manuals:	
1.	Practical biochemistry and human physiology lab manual pdf&id=293e4b82df17c4b88ed428f8d477606a.pdf

E-Resources	
1.	https://libraries.ou.edu/subjects/chemistry-biochemistry
2.	https://libguides.library.usyd.edu.au/c.php?g=508174&p=3476667
3.	https://journals.physiology.org/doi/full/10.1152/advan.00007.2017

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
(Autonomous Institution, Affiliated to Anna University ,Chennai)
Elayampalayam, Tiruchengode – 637 205

Programme	**B.E.**	Programme code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**III**

Course code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC317	**Electron Devices and Circuits Laboratory**	0	0	2	1	50	50	100

Course Objective

The student should be made to,

- Learn the characteristics of basic electronic devices such as Diode, BJT,FET, SCR.
- Design and analyze BJT configurations.
- Learn hardware implementation and testing of analog circuits.
- Design amplifier circuits to meet desired specifications.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Demonstrate V-I characteristics of PN junction diode & Zener diode.	K2
CO2: Illustrate the operation of BJT and its Characteristics.	K2
CO3: Design, build and test any analog circuits for handling real life projects.	K3
CO4: Exposed to circuit simulations using present meter technology MOSFETs.	K4
CO5: Apply P-spice & Develop a working model of an electronic circuit.	K3

Pre-requisites U19EE201 Basic Electrical and Electronics Engineering

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	2	1	2										2		
CO 2	2	1	2										2		
CO 3	2	1	2										2		
CO 4	2	1	2										2		
CO 5	2	1	2										2		

Course Assessment Methods

Direct
1. Pre lab and Post lab 2. End-Semester examinations
Indirect
1. Course - end survey

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List of Experiments	
1. Characteristics of PN Junction Diode. 2. Zener diode Characteristics & Regulator using Zener diode. 3. Common Emitter input-output Characteristics. 4. FET Characteristics. 5. SCR Characteristics. 6. Frequency Response of CE amplifier and its Spice simulation. 7. Design of CC Amplifier for a specific output impedance and its Spice Simulation. 8. Spice simulation of CS, CG, and CD configuration of MOSFET amplifiers with various active load configurations. 9. Design of Differential Amplifiers and its CMRR measurement. 10. Design and analysis class A power amplifier.	
Total Periods	**45**

Suggested Lab Manuals:

1. David A. Bell, " Laboratory manual for Electronic Devices and Circuits", PHI, 4th Edition,2001.

E-Resources

1.	https://www.electronics-tutorials.ws/diode/diode_2.html
2.	https://nptel.ac.in/courses/117102061/
3.	https://www.sciencedirect.com/topics/physics-and-astronomy/optical-device

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Programme	**B.E.**	Programme Code		**106**		Regulation		**2019**
Department	**BIOMEDICAL ENGINEERING**					Semester		**III**
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCSY3	**Numerical Ability**	3	0	0	-	100	-	100
Content of the syllabus								
Unit – I	**NUMBER SYSTEM**					Periods		**6**
Number Properties – HCF – LCM - Square root – Cube root – Simplification – Averages.								
Unit – II	**DIRECT PROPORTIONAL PROBLEMS**					Periods		**8**
Percentage - Profit & Loss –. Ratio & Proportions – Mixture & Allegations - Problem on Ages.								
Unit – III	**INDIRECT PROPORTIONAL PROBLEMS**					Periods		**8**
Time & Work – Pipes & Cisterns - Time, Speed & Distance – Boats & Streams – Races & Games of Skills.								
Unit – IV	**BANKER'S PROBLEMS**					Periods		**4**
Simple Interest – Compound Interest – Logarithms – Partnership - Discounts.								
Unit – V	**MISCELLANEOUS PROBLEMS**					Periods		**4**
Mensuration: Area & perimeter – Volume & Surface Area – Geometry-Trigonometry.								
						Total Periods		**30**
Text Books								
1.	Dinesh Khattar- The Pearson guide to Quantitative Aptitude for Competitive Examinations 3rd edition.							
References								
1.	R.S. Aggarwal - Quantitative Aptitude for Competitive Examinations.							

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**IV**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MA408	**Probability and Statistics**	3	1	0	4	50	50	100

Course Objective

The students should be made to

- Proficiently understand the expected value, variance, and higher-order moments of random variables (for both discrete and continuous types).
- Analyze and interpret statistical data using appropriate probability distribution.
- Know and differentiate between one dimensional and Two dimensional random variables.
- Identify and demonstrate suitable sampling and data collection process.
- Identify testing of hypothesis for all size of samples.

Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Translate the density and distribution functions for discrete and continuous variables.	K1,K3
	CO2: Enable to identify various probability distributions.	K2,K3
	CO3: Use the central limit theorem to compute probabilities.	K1,K5
	CO4: Apply appropriate modern technology to explore probability/statistical concepts.	K3,K4
	CO5: Ability to test the hypothesis using suitable statistical test.	K3,K4

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3		3								3	2	
CO 2	3				2								3	2	
CO 3	3		2										3	2	
CO 4	3	2											3	3	
CO 5	3												3	3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**RANDOM VARIABLES**	Periods	**12**
Introduction to probability, random variables, Probability mass function, Probability generating function, moments, moment generating function, Chebyshev inequality.			
Unit – II	**SPECIAL DISTRIBUTIONS**	Periods	**12**
Special discrete and continuous distributions: Binomial, geometric and Poisson distributions, Uniform, Gaussian, Exponential and Gamma distributions.			
Unit – III	**TWO DIMENSIONAL RANDOM VARIABLE**	Periods	**12**
Function of a random variable. Joint distributions, Marginal and Conditional distributions, Transformation of random variables, correlation and regression - central limit theorem.			
Unit – IV	**ESTIMATION THEORY**	Periods	**12**
Sampling distributions, point estimation, unbiasedness, consistency, maximum likelihood estimation, Confidence intervals for parameter in one sample from normal population.			
Unit – V	**TESTING OF HYPOTHESIS**	Periods	**12**
Basic Definitions:- (Population, Sampling, Tests of Significance, Testing a Hypothesis, Null Hypothesis, Alternative Hypothesis, Level of Significance, Types of Errors) – Testing of Hypothesis using : 't'-Test , 'F'-Test , Chi Square Test (ψ^2) - Test for Independence of Attributes & Goodness of Fit.			
		Total Periods	**60**

Text Books	
1.	Montgomery, D.C. and Runger, C.G., Applied Statistics and Probability for Engineers, 6th Edition, Wiley Students Edition, Wiley, 2016.
2.	Ravichandran, J., Probability and statistics for Engineers, 1st Edition, Wiley India Ltd, 2012.
References	
1.	Gupta S.C. and Kapoor V.K, Fundamentals of Mathematical Statistics, 1st Edition, Sultan an Sons, 2001.
2.	Devore, J.L., Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning, 2011.
3.	Johnson, R.A., Miller, I. and Freund, J., Miller & Freund's Probability and Statistics for Engineers 8th Edition, Pearson Education, 2010.
4.	Ronald E.Walpole; Raymond H.M.yers; Stiaron L. Myers,"Probability and Statistics for Engineering and the Scientists",Pearson Publishers, 7th Edition,2004.
5.	Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
E-Resources	
1.	https://online.stanford.edu ›
2.	www.learnerstv.com/Free-engineering-Video-lectures
3.	www.nptel.ac.in

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**IV**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM406	**Medical Physics**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Study principles and effects of ionizing and non-ionizing radiation in human body. • Discuss the physics of the senses. • Explore the effects of radiation in matter and how isotopes are produced. • Understand various detectors for detecting the presence of ionizing radiation.	
Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Explain about non-ionizing radiation, interaction with tissue and its effects.	K1,K2
	CO2: Define and compare intensities of sensory stimuli.	K2,K3
	CO3: Summarizes how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare.	K1,K2
	CO4: Explain the fundamentals of radioactivity and radioactive isotopes.	K1,K2
	CO5: Illustrates the methods of detecting and recording the ionizing radiation and its interaction with matter.	K2,K4
Pre-requisites	-	

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2		1								3	3		
CO 2	3	3		3								3	3		
CO 3	3	3	3	3	3	3	3				2	3	3	3	
CO 4	3	3	3	3	3	2	1					3	3	3	
CO 5	3	3		3	3				3			3		3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**NON-IONIZING RADIATION AND ITS MEDICAL APPLICATIONS**	Periods	**9**
Introduction and objectives - Tissue as a leaky dielectric - Relaxation processes, Debye model, Cole–Cole model, Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light, Measurement of light and its unit- limits of vision and color vision an overview, Ultraviolet.			
Unit - II	**PHYSICS OF THE SENSES**	Periods	**7**
Introduction and objectives - Cutaneous sensation - The chemical senses – Audition –Vision – Psychophysics.			
Unit – III	**PRINCIPLES OF RADIOACTIVE NUCLIDES**	Periods	**10**
Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology ,Decay series, Production of radionuclides – Cyclotron produced Radionuclide-Reactor produced Radio- nuclide-fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclides, radionuclide Generator-Technetium generator.			
Unit - IV	**RADIOACTIVE DECAY AND INTERACTIONOF RADIATION WITH MATTER**	Periods	**11**
Spontaneous Fission- Isomeric Transition-Alpha Decay-Beta Decay-PositronDecay-Electron Capture-Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter- Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation, Interaction of neutron with matter and their clinical significance.			
Unit – V	**SCINTILLATION, SEMICONDUCTOR and GAS FILLED DETECTORS**	Periods	**9**
Scintillation Detectors - Solid Scintillation Counters - Gamma-Ray Spectrometry-Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters-Thyroid Probe-Principles of Gas-Filled Detectors - Ionization Chambers-Geiger–Müller Counters,Applications of Radiation Detectors in Health- Care.			
		Total Periods	**45**
Text Books			
1.	Gopal B. Saha, —Physics and Radiobiology of Nuclear Medicine‖, 4th Edition, Springer, 2013.		
2.	B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, —Medical Physics and Biomedical Engineering‖, 2nd Edition, IOP Publishers.2001.		
References			
1.	S.Webb — The Physics of Medical Imaging‖, Taylor and Francis, 1988.		
2.	J.P.Woodcock, —Ultrasonic,Medical Physics Handbook series 1‖, Adam Hilger, Bristol, 2002.		
3.	HyltonB.Meire and Pat Farrant —Basic Ultrasound‖ John Wiley & Sons, 1995.		
E-Resources			
1.	http://nptel.ac.in/		
2.	www.medphys.org/		
3.	https://ndl.iitkgp.ac.in/		

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
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Programme	B.E.	Programme Code	106	Regulation	2019
Department	BIOMEDICAL ENGINEERING			Semester	IV

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CS417	Data Structures	3	0	0	3	50	50	100

Course Objective

The student should be made to,

- Impart the basic concept of list ADT.
- Learn the linear data structures such as stack and queue.
- Describe the non linear data structures such as Tree and Graphs.
- Examine various algorithms for finding shortest path and minimum spanning tree.
- Analyze various searching, sorting algorithms and hashing techniques.

Course Outcome

At the end of the course, the student should be able to,	Knowledge level
CO1: Implement abstract data type for list and operations.	K3
CO2: Apply the stack and queue data structure for problem solution.	K3, K4
CO3: Analyze various tree data structures to implement various applications	K4
CO4: Critically analyze and solve the problems in finding shortest path and minimum spanning.	K5
CO5: Demonstrate the various searching, sorting algorithms and hashing techniques	K3,K4

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3	2								2	2	2	
CO 2	3	3	3	2								2	2	2	
CO 3	3	3	3	3								2	2	3	
CO 4	3	3	3	2								2	2	3	
CO 5	3	3	3	3								2	2	3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**LINEAR DATA STRUCTURE – LIST**	Periods	**9**
Abstract Data Types (ADTs) – List ADT – Array Implementation – Linked List Implementation — Singly Linked Lists – Circular Linked Lists – Doubly Linked Lists – Applications of Lists – Polynomial operations (Insertion, Deletion, Merge, Traversal).			
Unit - II	**LINEAR DATA STRUCTURE – STACKS, QUEUES**	Periods	**9**
Stack ADT – Operations – Application: Evaluating Arithmetic Expressions – Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – DeQueue – Applications of queues.			
Unit – III	**NON LINEAR DATA STRUCTURE – TREES**	Periods	**9**
Terminologies – Tree ADT – Binary Tree – Tree Traversals – Expression Trees – Applications of Trees – Binary Search Tree ADT - AVL Trees – B- Trees – Heap – Applications of Heap.			
Unit - IV	**NON LINEAR DATA STRUCTURES – GRAPHS**	Periods	**9**
Definition – Representation of Graph – Types of graph – Breadth-First Traversal – Depth-First Traversal – Topological Sort – Shortest Path Algorithms - Minimum Spanning Tree - Applications of graphs.			
Unit – V	**SEARCHING, SORTING & HASHING TECHNIQUES**	Periods	**9**
Searching: Linear Search – Binary Search, Sorting: Bubble sort – Selection sort – Insertion sort – Shell sort – Quick Sort, Hashing: Hash Functions – Collision Resolution Techniques – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.			
		Total Periods	**45**
Text Books			
1.	Mark Allen Weiss — Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 2011.		
2.	Reema Thareja — Data Structures Using C, Second Edition , Oxford University Press, 2011		
References			
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein — "Introduction to Algorithms", Second Edition, Mcgraw Hill, 2002.		
2.	Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, — "Fundamentals of Data Structures in C", Second Edition, University Press, 2008.		
3.	Stephen G. Kochan, — "Programming in C", Third edition, Pearson Education.		
4.	Joe Bentley — "Programming Pearls", Second Edition, Pearson Education, 2006.		
5.	Steven S. Skiena — "The Algorithm Design Manual", Second Edition, Springer, 2010.		
E-Resources			
1.	https://www.edx.org/course/algorithms-and-data-structures		
2.	https://hackr.io/tutorials/learn-data-structures-algorithms		
3.	https://www.learneroo.com/subjects/8		

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Elayampalayam, Tiruchengode – 637 205

Programme	B.E	Programme Code	106	Regulation	2019
Department	BIOMEDICAL ENGINEERING			Semester	IV

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC419	Signals and Systems	3	0	0	3	50	50	100

Course Objective

The student should be made

- Introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
- Introduce visualization and mathematical representation of continuous-time and discrete-time signals.
- Teach the applications of laplace and fourier transforms in the analysis of continuous time signals.
- Teach the applications of z and fourier transforms in the analysis of discrete –time signals.
- Develop the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

Course Outcome

At the end of the course, the student should be able to	Knowledge Level
CO1: Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.	K4
CO2: Classify systems based on their properties and determine the response of LSI system using convolution.	K3
CO3: Analyze system properties based on impulse response and Fourier analysis.	K4
CO4: Apply the Laplace transform and Z- transform for analyze of continuous-time and discrete-time signals and systems.	K4
CO5: Understand the process of sampling and the effects of under sampling.	K3

Pre-requisites

-

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2											3	1	2
CO 2	3	2	3										3	1	2
CO 3	3	2	2	2									3	1	2
CO 4	3	2											3	1	2
CO 5	3	2	3	2									3	1	2

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
1. Course - end survey **(student participation, placement details can also be included as an indirect tool)**

Content of the syllabus

Unit – I	**CLASSIFICATION OF SIGNALS AND SYSTEMS**	Periods	**9**
Continuous Time Signals(CT Signals), Discrete Time Signals(DT Signals) – Step ,Ramp, Pulse, impulse, Exponential, Classification of CT and DT Signals – Periodic and Aperiodic , Random Signals , CT Systems and DT Systems , Basic Properties of Systems – Linear Time Invariant Systems and Properties.			
Unit - II	**ANALYSIS OF CONTINUOUS TIME SIGNALS**	Periods	**9**
Fourier Series Analysis – Spectrum of Continuous Time Signals, Fourier Transform and Laplace Transform in Signal Analysis.			
Unit – III	**LINEAR TIME INVARIANT -CONTINUOUS TIME SYSTEMS**	Periods	**9**
Differential Equation , Block diagram representation , Impulse Response , Convolution integral , Frequency Response , Fourier and Laplace Transforms in Analysis , State Variable Equations and Matrix Representation of Systems.			
Unit – IV	**ANALYSIS OF DISCRETE TIME SIGNALS**	Periods	**9**
Sampling of CT Signals and Aliasing, DTFT and Properties, Z-Transform and Properties of Z-Transform.			
Unit – V	**LINEAR TIME INVARIANT – DISCRETE TIME SYSTEMS**	Periods	**9**
Difference Equations , Block Diagram Representation , Impulse Response , Convolution Sum , LTI Systems Analysis Using DTFT and Z-Transforms, State Variable Equations and Matrix Representation of Systems.			
		Total Periods	**45**

Text Books

1.	Allan V.Oppenheim, S.Wilsky and S.H.Nawab, Signals and Systems, Pearson Education, 2007.
2.	Simon Haykins and Barry Van Veen, Signals and Systems John Wiley & sons, Inc, 2004.

References

1.	Robert A. Gabel and Richard A.Roberts, "Signals & Linear Systems", John Wiley, 3rd Edition, 1987.
2.	Rodger E. Ziemer, William H. Tranter, D. Ronald Fannin. "Signals & systems", 4th Edition, Pearson Education, 2002.
3.	Edward W Kamen & Bonnie's Heck, "Fundamentals of Signals and Systems", Pearson Education, 2007.
4.	B. P. Lathi, "Principles of Linear Systems and Signals", Oxford, 2nd Edition, 2009.
5.	S. Haykin and B. Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2003.

E-Resources

1.	https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/
2.	https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/assignments/
3.	http://www.eng.ucy.ac.cy/cpitris/courses/ece623/notes/SignalsAndSystems.pdf

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
(Autonomous Institution, Affiliated to Anna University ,Chennai)
Elayampalayam, Tiruchengode – 637 205

Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**IV**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC420	**Linear Integrated Circuits**	3	0	0	3	50	50	100

Course Objective

The student should be made to,

- Illustrate the concept of Monolithic IC fabrication technique and characteristics Op-amp.
- Interpret the various applications of Op-amp.
- Understand the function of Analog Multiplier and the applications of PLL circuits.
- Categorize the ADCs and DACs with the applications.
- Elaborate the concept of various waveform generation and regulator circuits.

Course Outcome

At the end of the course, the student should be able to,	Knowledge Level
CO1: Describe about Monolithic IC fabrication technique and compare the characteristics various Op-amp based ICs.	K2
CO2: Demonstrate the various applications of Op-amp.	K2
CO3: Analyze the functional blocks and the applications of PLL circuits.	K4
CO4: Examine the operation of ADCs and DACs.	K3
CO5: Define the internal circuits of waveform generation and regulator circuits.	K3

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3			2	2	2	2			2		2	3	2	
CO 2	2		2			2	2		2	2		2	2	2	
CO 3	3		3			3	2		2	2			3		2
CO 4	2			2		2	2		2	2		2	3		2
CO 5	2		2			2	2		2	2		2	2	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool, Quiz and Seminar 3. End-Semester examinations
Indirect
1. Course - end survey.

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Content of the syllabus			
Unit – I	**INTRODUCTION TO LINEAR IC**	Periods	**9**
Advantages of ICs over discrete components-Manufacturing process of monolithic ICs-Characteristics of Ideal and Practical Operational amplifier - Parameters of Operational amplifier- Inverting and Non inverting amplifier configurations, General operational amplifier stages and Internal circuit diagrams of IC 741, DC and AC performance characteristics-Slew rate-Open and Closed Loop configurations.			
Unit – II	**APPLICATIONS OF OPERATIONAL AMPLIFIER**	Periods	**9**
Adder-Difference Amplifier-Differentiator-Integrator-Voltage Follower-Voltage to Current, Current to Voltage converters-Instrumentation amplifier-Logarithmic amplifier-Phase Shift Circuits-Comparator-Schmitt trigger-Precision rectifier- Clipper and Clamper- Low Pass and High Pass Butterworth filters.			
Unit – III	**ANALOG MULTIPLIER AND PLL**	Periods	**9**
Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell - Analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage Controlled Oscillator, Monolithic PLL IC 565, Application of PLL.			
Unit – IV	**A-D AND D-A CONVERTER**	Periods	**9**
Analog and Digital Data Conversions, D/A converter – Specifications - Weighted resistor type, R-2R Ladder type, Voltage Mode and Current Mode, R-2R Ladder types - Switches for D/A converters, IC DAC-08, A/D Converters –Specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type - Conversion Times of typical IC ADC.			
Unit – V	**WAVEFORM GENERATORS AND SPECIAL FUNCTION ICs**	Periods	**9**
Sine wave generators, Multivibrators and Triangular wave generator, Saw tooth wave generator-Timer IC 555-IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Frequency to Voltage and Voltage to Frequency Converters - Audio Power amplifier - Video Amplifier - Isolation Amplifier - Opto couplers and Fibre optic IC.			
		Total Periods	45

Text Books	
1.	Seringo Franco, "Design with operational amplifiers and analog Integrated Circuits", Fourth Edition McGraw-Hill Education - Europe, 2014.
2.	D. Roy Choudhry, Shail Jain, "Linear Integrated Circuits", Fourth Edition, New Age International Pvt. Ltd., 2011.
References	
1.	B.S.Sonde, "System design using Integrated Circuits", New Age Publication, Second Edition, 2011,
2.	Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, Fifth Edition, 2010.
3.	Ramakant A.Gayakwad, "OP-AMP and Linear ICs", Prentice Hall / Pearson Education, Fourth Edition, 2012.
4.	J.Michael Jacob, "Applications and Design with Analog Integrated Circuits", Prentice Hall of India, Second Edition, 2009.
5.	William D.Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson Education, 2014.
6.	K.Lal Kishore, "Operational Amplifier and Linear Integrated Circuits", Pearson Education; First edition, 2012.
7.	G B Clayton ,Steve Winder, "Operational Amplifiers", Fifth Edition, Elsevier science, 2003.

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E-Resources	
1.	https://www.tutorialspoint.com/linear_integrated_circuits_applications/basics_of_linear_integrated_circuits_applications.htm
2.	https://www.google.com/search?biw=1280&bih=609&sxsrf=ACYBGNR4y8KbShS2jrEhlInQ_dcginKWYw%3A1573192577727&ei=gQPFXZbxK4-WwgPFm6zYCQ&q=linear+integrated+circuits+by+roy+choudhary&oq=linear+integrated+circuiT+&gs_l=psy-ab.1.9.35i305i39l2j0i10l8.19232.23470..28872...0.3..0.1507.4634.0j2j1j0j1j1j0j1j1.....0....1..gws-wiz.....0i71j35i39j0j0i20i263.WTwHuOjzWY4
3.	https://www.chegg.com/tutors/what-are-Linear-Integrated-Circuits/

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**IV**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM407	**Pathology and Microbiology**	3	0	0	3	50	50	100

Course Objective

The student should be made to,

- Gain knowledge on the structural and functional aspects of living organisms.
- Explain about microscope
- Know the importance of public health
- Know the etiology and remedy in treating the pathological diseases.
- Empower the importance of public health.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Analyze structural and functional aspects of living organisms.	K2
	CO2: Explain the function of microscope	K2
	CO3: Discuss the importance of public health.	K4
	CO4: Describe methods involved in treating the pathological diseases.	K3
	CO5: Define the terms of the pathology	K3

Pre-requisites	-

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2				1		1				1	3	3	
CO 2	3	2				1		1				1	3	3	
CO 3	3	2				1		1				1	3	3	
CO 4	3	2				1		1				1	3	3	
CO 5	3	2				1		1				1	3	3	

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III. 2. Assignment: Simulation using tool, Quiz and Seminar. 3. End-Semester examinations.
Indirect
1. Course - end survey.

Content of the syllabus

Unit – I	**CELL DEGENERATION, REPAIR AND NEOPLASIA**	Periods	**9**
Cell injury - Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification- Dystrophic and Metastatic. cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours Autopsy and biopsy.			
Unit – II	**FLUID AND HEMODYNAMIC DERANGEMENTS**	Periods	**9**
Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders- Bleeding disorders, Anaemias, Leukaemias, Lymphomas Haemorrhage.			
Unit – III	**MICROBIOLOGY**	Periods	**9**
Structure of Bacteria and Virus. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria and virus, growth curve, identification of bacteria , culture media and its types , culture techniques and observation of culture. Disease caused by bacteria, fungi, protozoal, virus and helminthes.			
Unit – IV	**MICROSCOPES**	Periods	**9**
Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining.			
Unit – V	**IMMUNOPATHOLOGY**	Periods	**9**
Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto-immune disorders: Basic concepts and classification, SLE.Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.			
		Total Periods	**45**

Text Books

1.	Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, —Pathologic Basis of Diseases, 7th edition,WB Saunders Co. 2005 (Units I & II).
2.	Ananthanarayanan & Panicker, —Microbiology‖ Orientblackswan, 2017 10th edition. (Units III,IV and V).

References

1.	Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
2.	Dubey RC and Maheswari DK. —A Text Book of Microbiology‖ Chand & Company Ltd, 2007
3.	Prescott, Harley and Klein, —Microbiology‖, 10th edition, McGraw Hill, 2017

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E-Resources	
1.	https://scasm.org/resources/links
2.	http://dzumenvis.nic.in/microbiology_experts.html
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7158324/

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**IV**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC421	**Analog and Linear Integrated Circuits Laboratory**	0	0	2	1	50	50	100

Course Objective	The student should be made to • Analyze RC and LC oscillators. • Evaluate the output of amplifier circuits. • Design and test mathematical operation using OP-Amp. • Illustrate characteristics and of filter and oscillator. • Examine the operation of PLL.	
Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Design and construct the amplifiers and oscillators.	K6
	CO2: Evaluate the output of analog circuits.	K5
	CO3: Demonstrate the mathematical operation using OP-Amp.	K2
	CO4: Understand performance of filter and oscillator circuits.	K1
	CO5: Examine the operation of PLL.	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**													CO/PSO Mapping		
COs	Programme Outcomes (POs)												PSOs		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2			2			2	2	2			2	2	2
CO 2	3	2			2			2	2	2			2	2	
CO 3	2	2			2			2	2	2			3	2	2
CO 4	3	2			2			2	2	2			2	2	
CO 5	3	2			2			2	2	2			2		

Course Assessment Methods

Direct
1. Pre lab and Post lab Test 2. End-Semester examinations
Indirect
1. Course - end survey.

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Content of the syllabus	
1. Series and Shunt feedback amplifiers: Frequency response, input and output impedance calculation. 2. Design of R-C Oscillators (Phase Shift and Wien Bridge). 3. Design of Class – C tuned Amplifier. 4. Design of Astable and Bistable multivibrators. 5. Design of Differential amplifier and Determine its CMRR. 6. Inverting and Non inverting amplifiers using Op-Amp. 7. Integrator, Differentiator and Instrumentation Amplifier using Op-Amp. 8. Active Low pass filters, A/D and D/A convertor using OP-Amp. 9. PLL characteristics and its use as Frequency Multiplier. 10. Voltage Regulator using IC723.	
Total Periods	**45**
Text Books	
1.	David A.Bell, "Electronic devices and Circuits", Prentice Hall of India, 2004.
2.	D. Roy Choudhry, Shail Jain, "Linear Integrated Circuits", 4th Edition, New Age International Pvt. Ltd., 2011.
E-Resources	
1.	https://www.electronics-tutorials.ws/amplifier/
2.	https://www.multisim.com/help
3.	https://www.tutorialspoint.com/linear_integrated_circuits_applications/basics_of_linear_integrated_circuits_applications.htm
4.	https://www.google.com/search?biw=1280&bih=609&sxsrf=ACYBGNR4y8KbShS2jrEhlInQ_dcginKWYw%3A1573192577727&ei=gQPFXZbxK4-wgPFm6zYCQ&q=linear+integrated+circuits+by+roy+choudhary&oq=linear+integrated+circuiT+&gs_l=psy-.1.9.35i305i39l2j0i10l8.19232.23470..28872...0.3..0.1507.4634.0j2j1j0j1j1j0j1j1.....0....1..gwsiz.....0i71j35i39j0j0i20i263.WTwHuOjzWY4
5.	https://www.chegg.com/tutors/what-are-Linear-Integrated-Circuits/

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**IV**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM408	**Pathology and Microbiology Laboratory**	0	0	2	1	50	50	100

Course Objective	The student should be made to • Examine urine samples. • Use Compound microscope. • Practice on chemical examinations. • Practice on Cryoprocessing. • Practice on Histopathological examinations.	
Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Perform to examine urine samples.	K6
	CO2: Explain Compound microscope.	K5
	CO3: Demonstrate the chemical examinations.	K2
	CO4: Understand Cryoprocessing.	K1
	CO5: Examine the Histopathological examinations.	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2			2			2	2	2			2	2	2
CO 2	3	2			2			2	2	2			2	2	
CO 3	2	2			2			2	2	2			3	2	2
CO 4	3	2			2			2	2	2			2	2	
CO 5	3	2			2			2	2	2			2		

Course Assessment Methods

Direct
1. Pre lab and Post lab Test 2. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus	
1. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood). 2. Study of parts of compound microscope. 3. Histopathological slides of benign and malignant tumours. 4. Manual paraffin tissue processing and section cutting (demonstration). 5. Cryo processing of tissue and cryosectioning (demonstration). 6. Basic staining – Hematoxylin and eosin staining. 7. Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS. 8. Capsule stain. 9. Simple stain. 10. Gram stain. 11. AFB stain. 12. Antigen-Antibody reaction Immuno electrophoresis. 13. Slides of malarial parasites, micro filaria and leishmania donovani. 14. Haematology slides of anemia and leukemia. 15. Study of bone marrow charts.	
Total Periods	**45**
Text Books	
1.	Textbook of Medical Laboratory Technology, Ramnik Sood, 6thEdition, Jaypee Brothers Medical Publishers, 2009
E-Resources	
1.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7158324/
2.	https://www.pathlabs.org/clinicians/microbiology-testing/
3.	https://www.lalpathlabs.com/national-reference-laboratory/microbiology-and-serology.aspx

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**IV**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19CS418	**Data Structures Laboratory**	0	0	4	2	50	50	100

Course Objective	The student should be made to • Design and develop simple programs using data structures. • Apply linear data structures for various real time applications. • Develop programs to implement non linear data structures. • Design shortest path algorithm for various real life applications. • Write programs to implement for sorting and hashing.

Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Design and implement program for Linked List.	K3
	CO2: Implement the program for manipulating Stack.	K3
	CO3: Design and Implement programs for Binary Search tree and AVL tree.	K3,K4
	CO4: Implement the shortest path algorithms available in graph.	K4
	CO5: Apply appropriate sorting algorithm and hash functions that result in a collision free scenario for data storage and retrieval.	K3,K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3									2	2	2	
CO 2	3	3	3									2	2	2	
CO 3	3	3	3									2	2	3	
CO 4	3	3	3									2	2	2	
CO 5	3	3	3									2	2	2	

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Course Assessment Methods

Direct
1. Prelab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

SUGGESTED LIST OF EXPERIMENTS:

1. Represent a polynomial as a linked list and write functions for polynomial addition.
2. Implementation of stack and use it to convert infix to postfix expression.
3. Implementation of Binary Tree and Traversal Techniques.
4. Implementation of binary search tree.
5. Implementation of insertion in AVL trees.
6. Implementation of graphs using BFS and DFS.
7. Implementation of Djikstra's algorithm.
8. Implementation of Prim's algorithm using priority queue to find MST of an undirected graph.
9. Implementation of Merge sort using Divide and Conquer method.
10. Implementation of Hashing with open addressing.

Total Periods	**45**

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**			Regulation		**2019**
Department	**BIOMEDICAL ENGINEERING**					Semester		**IV**
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCSY4	**VERBAL ABILITY**	3	0	0	-	100	-	100

Content of the syllabus

Unit – I	**TENSES**	Periods	**6**

Purpose and rules of tenses and its keywords (focus should be given to present continuous, future continuous, present perfect, future perfect, present perfect continuous, past perfect continuous, future perfect continuous with more examples) - Direct and Indirect Speech – Voices.

Unit – II	**ARTICLES**	Periods	**6**

Purpose of Articles: Indefinite Article: If you want to say about ANY item, you should use the articles A / An. **A :** A European, A One Eyed beggar, A University, A Useful Website. Name of professions, Expression of quantity, To make a Proper noun a Common noun, With certain numbers, used before the word 'Half' when it follows a whole number. **Exceptions: Choosing A or An** There are a few exceptions to the general rule of using a before words that start with consonants and an before words that begin with vowels. The first letter of the word honor, for example, is a consonant, but it's unpronounced. In spite of its spelling, the word honor begins with a vowel sound. Therefore, we use an. **Example.**

The Definite Article:

Where to use the Definite Article -A specific item, a particular person or thing, Before superlative forms, Before double comparatives, Before musical instruments, Before rank or title, Before name of the political parties, armed forces, physical positions, Before a Proper noun when used as a Common noun, Before some adjectives to make them nouns, Before Ordinal numbers, Before the names of Oceans, Seas, Rivers, Canals, Deserts, Groups of Mountains and Groups of Islands, Before the names of the Things, which are unique in nature, Before the names of Planets and Satellites, Before Holy Books, Before the names of News Papers, Before the names of some countries, measuring expressions beginning with by. **Omission of articles**:

Before Plural countable noun, Before proper noun, Before languages, a single item of uncountable noun, Before name of the meals except adjective usage, Double expressions – with wife and fork, with hat and folk, from top to bottom, With the names of meals such as Breakfast, Before predicative nouns denoting a unique position, After type of / kind of / sort of / post of / title of / rank of / articles are not used. Ex. He is not that sort of man, Articles are not used with material nouns, After di-transitive verb articles should not be used except when it is used as mono transitive verb, Before the names of meals no article should be used in a general way except in particular causes.

Repetition of the articles

1. When two or more adjectives qualify the same noun, the article is used before the first adjective only; but when they qualify different nouns, expressed or understood, the article is used before each adjective.

PREPOSITIONS

a. Prepositions Of Time-On, In, At, Since, For, Ago, During, Before, After, Until, Till, To/Past, From/To, By
b. Prepositions Of Place- In, At, On, Off, By, Beside, Under, Over, Below, Above, Up And Down, Ago
c. Prepositions Of Directions/ Movements Across, Through, To, Into, Out Of, Onto, Towards, From
d. Other Prepositions- Of, By , About, For, With
e. Prepositions Usage with Its Context

Unit – III	**SENTENCE CORRECTION**	Periods	**6**

SENTENCE CORRECTION

a) In each of the following sentences, four options are given. You are required to identify the best way of writing the

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sentence in the context of the correct usage of standard written English. While doing so, you have to ensure the message being conveyed remains the same in all the cases.
b) For each of the following questions, a part or the whole of the original sentence has been underlined. You have to find the best way of writing the underlined part of the sentence.
c) In the following questions, you have to identify the correct sentence/s. For each of the following questions, find the sentence/s that are correct.
d) In each of the following questions, one or more of the sentences is/are incorrect. You have to identify the incorrect sentence/s.

SENTENCE IMPROVEMENT

a. Subject-Verb Agreement
b. Parallelism
c. Redundancy: The error of repeating the same thing.
d. Modifier
e. Comparisons
RULE: (a) When comparative degree is used with than, make sure that we exclude the thing compared from the rest of class of things by using the
f. Confusing words
i) Few and Less
ii) Few and A few
iii) Little and A Little
A little tact would have saved the situation(some tact).
Lay and Lie Lay, laid

Unit – IV	SENTENCE COMPLETION	Periods	6

SENTENCE COMPLETION: Purpose and usage of proper words. **SPOTTING ERRORS:**

a. Errors on conjunctions
b. Errors on 'if' clauses
c. Errors on adverbs
d. Errors on adjectives
e. Errors on prepositions
f. Errors on determiners
g. Errors on verbs
h. Errors on nouns
i. Errors on modifiers
j. Errors on degrees of comparison
k. Errors on subject-verb agreement
l. Errors on infinitives
m. Errors on pronouns
n. Errors on tenses
o. Redundancy errors
p. Errors on articles
q. Error on complex sentences

Unit – V	VOCABULARY	Periods	6

Synonyms: Root Based Word, Suffix Based Word. Antonyms - Contextual Vocabulary - Verbal Analogy

	Total Periods	30

Text Books

1.	Objective General English by SP Bakshi – Arihant Publication

References

1.	A modern Approach to verbal and non-verbal reasoning by R.S. Agarwal
2.	Word power made easy by Norman Lewis

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**V**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM509	**Bio Control Systems**	3	0	0	3	50	50	100
Course Objective	The student should be made • Understand the concept behind feedback and continuum in various systems and subsystems. • Analyze the systems in time and frequency domain and to understand the concept of Stability. • Apply mathematical modeling principles in understanding the various fundamental biological systems. • Analyze biological system models using MATLAB.							
Course Outcome	At the end of the course, the student should be able to							Knowledge level
	CO1: Understand the need for mathematical modeling of various systems, representation of systems in block diagrams and signal flow graphs and are introduced to biological control systems.							K2,K4
	CO2: Analyze the time response of various systems and discuss the concept of system stability.							K3,K4
	CO3: Analyze the frequency response characteristics of various systems using different charts.							K3,K5
	CO4: Understand the concept of modeling basic physiological systems.							K2,K5
	CO5: Comprehend the application aspects of time and frequency response analysis in physiological control systems.							K1,K3
Pre-requisites	-							

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**												**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2											3	2	
CO 2	3	2		1									3	2	
CO 3	2	2		1									3	2	
CO 4	2	2		1									2	2	
CO 5	3			2	2						1		2	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

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Unit – I	INTRODUCTION	Periods	9
Open and Closed loop Systems, Modelling and Block Diagrams, Block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, Introduction to Physiological control systems- Illustration, Linear models of physiological systems, Difference between engineering and physiological control system.			
Unit – II	**TIME RESPONSE ANALYSIS**	Periods	**9**
Step and impulse responses of first order and second order systems, time domain specifications of first and second order systems, steady state error constants, Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability.			
Unit – III	**FREQUENCY RESPONSE ANALYSIS**	Periods	**9**
Frequency domain specifications - Polar plots, Bode plots, Nyquist plot, Nyquist stability criterion, closed loop stability, Constant M and N circles, Nichol's chart.			
Unit – IV	**BIOLOGICAL SYSTEM MODELS**	Periods	**9**
Model development of Cardiovascular system- Heart model-circulatory model, Pulmonary mechanics- Lung tissue visco-elastance-chest wall- airways, Interaction of Pulmonary and Cardiovascular models, Endocrine Control Systems, Skeletal Muscle Servomechanism, Oculo-motor system, sugar level Control Mechanism. Temperature control, Blood pressure control.			
Unit – V	**BIOLOGICAL CONTROL SYSTEM ANALYSIS**	Periods	**9**
Static analysis of physiological systems – Regulation of cardiac output, Regulation of ventilation. Simple models of muscle stretch reflex action, Study of steady state analysis of muscle stretch reflex action, Study of transient response analysis of neuromuscular reflex model action, Study of frequency response of circulatory control model, Stability analysis of Pupillary light reflex.			
		Total Periods	**45**

Text Books

1.	I.J. Nagarath and M. Gopal —Control Systems Engineering", Fifth Edition, Anshan Publishers, 2008.
2.	Michael C K Khoo, —Physiological Control Systems‖, IEEE Press, Prentice Hall of India, 2005.

References

1.	Benjamin C. Kuo, —Automatic Control Systems‖, Prentice Hall of India, 1995.
2.	John Enderle Susan Blanchard, Joseph Bronzino —Introduction to Biomedical Engineering‖, second edition, Academic Press, 2005.
3.	Richard C. Dorf, Robert H. Bishop, —Modern control systems‖, Pearson, 2004.

E-Resources

1.	https://www.technicalsymposium.com/newbiomed_vsem.html
2.	https://www.slideshare.net/mathupuji/biological-control-systems-system-conceptsmathankumars-vmkvec
3.	https://www.vignan.ac.in/subjectsnew/16BM302.pdf

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Programme	**B.E**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**V**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC411	**Digital Signal Processing**	3	1	0	4	50	50	100

Course Objective

The student should be made to

- Learn Discrete Fourier transform and its properties.
- Know the characteristics of FIR filters and learn methods to design FIR filters.
- Know the characteristics of IIR filters and learn methods to design IIR filters.
- Study the effects of finite word length effects.
- Study about Digital Signal Processor and its programming.

Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Analyze and apply DFT for the analysis of digital signals & systems.	K4
	CO2: Design and Realize Finite Impulse Response filters.	K6
	CO3: Design and Realize Infinite Impulse Response filters.	K6
	CO4: Analyze the effects of finite word length effects.	K4
	CO5: Understand the architecture and programming of DSP processors.	K1

Pre-requisites	Signal and Systems

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3	3	2	3					2	3	3	3	3
CO 2	3	3	3	3	2	3					2	3	3	3	3
CO 3	3	3	3	3	2	3					2	3	3	3	3
CO 4	3	3	3	3	2	3					2	3	3	3	3
CO 5	3	3	3	3	2	3					2	3	3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**DISCRETE FOURIER TRANSFORM**	Periods	**9+3**
Review of discrete-time signals & systems, Discrete Fourier Transform : Properties , Inverse DFT , Circular Convolution, Fast Fourier Transform: Radix-2 FFT, Decimation-in-time and Decimation-in-frequency algorithms & its applications ,Overlap-add & overlap-save methods.			
Unit - II	**INFINITE IMPULSE RESPONSE FILTERS**	Periods	**9+3**
Characteristics of practical frequency selective filters. characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.			
Unit – III	**FINITE IMPULSE RESPONSE FILTERS**	Periods	**9+3**
Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations.			
Unit - IV	**FINITE WORD LENGTH EFFECTS**	Periods	**9+3**
Representation of numbers-ADC Quantization noise, derivation for quantization noise power, over flow error, co-efficient quantization error, Product Quantization error-truncation & rounding errors, limit cycle oscillation.			
Unit – V	**DIGITAL SIGNAL PROCESSORS & MULTIRATE SIGNAL PROCCESSING**	Periods	**9+3**
DSP functionalities - Circular buffering – Pipelining - DSP architecture – Fixed (C5X)and Floating point(C54X) architecture principles – addressing modes - Simple programming examples. Mathematical description of change of sampling rate, Interpolation and Decimation, Decimation by an integer factor, Interpolation by an integer factor, - Sampling rate conversion by a rational factor.			
		Total Periods	**60**

Text Books	
1.	John G. Proakis & Dimitris G.Manolakis, —Digital Signal Processing – Principles, Algorithms & Applications‖, Fourth Edition, Pearson Education / Prentice Hall, 2007.(Unit I – IV).
2.	B.Venkataramani & M. Bhaskar, "Digital Signal Processor Architecture, Programming and Application", TMH 2002.(Unit V).
References	
1.	Emmanuel C. Ifeachor & Barrie. W. Jervis, —Digital Signal Processing‖, Second Edition, Pearson Education / Prentice Hall, 2002.
2.	Alan V Oppenheim, Ronald W Schafer, John R Buck, "Discrete Time Signal Processing",Pearson,2009.
3.	Sanjit K. Mitra, —Digital Signal Processing – A Computer Based Approach‖, Tata Mc Graw Hill, 2007.
4.	Andreas Antoniou, —Digital Signal Processing‖, Tata Mc Graw Hill, 2006.
E-Resources	
1.	https://engineering.purdue.edu/~ee538/DSP_Text_3rdEdition.pdf
2.	https://www.scribd.com/doc/217906199/Digital-signal-processors-A-Venkatramani
3.	https://nptel.ac.in/courses/117102060/

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC521	**Analog and Digital Communication**	3	1	0	4	50	50	100

Course Objective	The student should be made to • Fundamental understanding on Communication Systems with emphasis on analog modulation techniques and noise performance. • Introduce random processes and their characteristics. • Get acquainted with the process of sampling, quantization and coding. • Learn baseband pulse transmission, Nyquist criterion and solutions. • Understand baseband and band pass signal transmission and reception techniques.	
Course Outcomes	At the end of the course, the student should be able to	Knowledge Level
	CO1: Comprehend and appreciate the significance and role of this course in the present contemporary world.	K3
	CO2: Evaluate the influence of noise on communications signals.	K6
	CO3: Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.	K4
	CO4: Apply line coding and pulse shaping techniques for data transmission.	K4
	CO5: Design and implement band pass signaling schemes.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2							2			3		2
CO 2	3	2	2										3		2
CO 3	3	2	3							2			3		
CO 4	3	2									2			3	
CO 5	3	2												3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**AMPLITUDE AND ANGLE MODULATION SYSTEMS**	Periods	**9**
Generation and demodulations of AM, DSBSC, SSB and VSB signals-voltage, current and power relationship- frequency spectrum for sinusoidal AM -AM transmitter and receiver. Generation and Demodulation of FM –FM transmitter. Frequency and Phase Modulation-Equivalence between FM and PM.			
Unit – II	**NOISE THEORY**	Periods	**9**
Gaussian Random Process-Stationary Random Process- Noise – Shot noise, Partition noise, Burst noise, Thermal noise and white noise; Narrow band noise, Noise factor, Noise temperature; Noise Figure.			
Unit – III	**DIGITAL COMMUNICATION**	Periods	**9**
Digital Communication: Functional Description- Channel Classification - Low pass sampling-Aliasing-Signal Reconstruction-Quantization-Uniform and Non Uniform Quantization-Quantization Noise-Logarithmic Companding of Speech signal-PCM-TDM			
Unit – IV	**BASEBAND TRANSMISSION TECHNIQUES**	Periods	**9**
Properties of Line codes-Power spectral density of Unipolar/Polar RZ,NRZ-Bipolar NRZ,Manchester ISI, Nyquist criterion for distortion less transmission-Pulse Shaping-Correlative coding-Mary Schemes-Eye pattern-Equalization.			
Unit – V	**BAND PASS MODULATION TECHNIQUES**	Periods	**9**
Amplitude Shift Keying, Binary Phase Shift Keying- Quadrature Amplitude Modulation- Binary Frequency Shift Keying-Quadrature Phase Shift Keying-Carrier synchronization, Structure of Non coherent receivers-Principle of DPSK.			
		Total Periods	**45**

Text Books	
1.	B.P.Lathi, "Modern Digital and Analog Communication Systems", 3rd Edition, Oxford Press, 2011.
2.	Simon Haykins, "Digital Communications", John Wiley, 2013.
References	
1.	Simon Haykin, "Communication Systems", John Wiley & Sons, Newark, 4th Edition, 2001.
2.	Dennis Roddy & John Coolen – "Electronic Communication"4th Edition, Prentice Hall of India.
3.	John.G.Proakis, "Digital Communication", 4th Edition, Pearson Education, 2006.
4.	Amitabha Bhattacharya, "Digital Communications", Tata McGraw Hill, 2006.
5.	Sam K.Shanmugam —Digital & Analog Communication systems‖ John Wiley,2008.
E-Resources	
1.	https://edisciplinas.usp.br/pluginfile.php/5251120/mod_resource/content/1/B.%20P.%20Lathi%2C%20Zhi%20Ding%20%20Modern%20Digital%20and%20Analog%20Communication%20Systems-Oxford%20University%20Press%20%282009%29.pdf
2.	https://books.google.co.in/books/about/Digital_Communication_Systems.html?id=YGZXAAAACAAJ&redir_esc=y
3.	http://web.stanford.edu/class/ee359/doc/WirelessComm_Chp1-6_Dec182019.pdf

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM510	**Biomedical Instrumentation**	3	0	0	3	50	50	100

Course Objective

The student should be made to

- Illustrate origin of bio potentials and its propagations .
- Understand the different types of electrodes and its placement for various recordings.
- Design bio amplifier for various physiological recordings.
- Learn the different measurement techniques for non-physiological parameters.
- Summarize different biochemical measurements.

Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Differentiate different bio potentials and its propagations.	K2,K4
	CO2: Illustrate different electrode placement for various physiological recordings.	K3,K4
	CO3: Design bio amplifier for various physiological recordings.	K3,K5
	CO4: Explain various techniques for non-electrical physiogical measurements.	K2,K5
	CO5: Demonstrate different biochemical measurement techniques.	K1,K3

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	2	3	3	3	2	3						2	3	3	2
CO 2	2	3	3	2	2	3						2	3	2	2
CO 3	1	3	3		2	2						2	3	3	3
CO 4	1	2	2	2	2	1						2	3	3	1
CO 5	1	2	2	2	2	1						2	3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment: Simulation using tool 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**BIOPOTENTIAL ELECTRODES**	Periods	**9**
Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, Contact impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes surface, needle and micro electrodes and their equivalent circuits. Recording problems - motion artifacts, measurement with two electrodes.			
Unit – II	**BIOPOTENTIAL MEASUREMENTS**	Periods	**9**
Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system, Principles of vector cardiography.EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG and EGG.			
Unit – III	**SIGNAL CONDITIONING CIRCUITS**	Periods	**9**
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering.			
Unit – IV	**MEASUREMENT OF NON-ELECTRICAL PARAMETERS**	Periods	**9**
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.			
Unit – V	**BIOCHEMICAL MEASUREMENT AND BIOSENSORS**	Periods	**9**
Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description) – Bio Sensors – Principles – amperometric and voltometric techniques.			
		Total Periods	**45**

Text Books	
1.	Leslie Cromwell, —Biomedical Instrumentation and measurement‖, 2nd edition, Prentice hall of India, New Delhi, 2015.
References	
1.	John G. Webster, —Medical Instrumentation Application and Design‖, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.
2.	Joseph J. Carr and John M. Brown, —Introduction to Biomedical Equipment Technology, Pearson Education, 2004.
3.	Myer Kutz, —Standard Handbook of Biomedical Engineering and Design‖, McGraw Hill Publisher, 2003.
4.	Khandpur R.S, —Handbook of Biomedical Instrumentation‖, 3rd edition, Tata McGraw-Hill New Delhi, 2014.
E-Resources	
1.	https://learnengineering.in
2.	www.learnerstv.com/Free-engineering-Video-lectures
3.	www.nptel.ac.in

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME01	**Bio MEMS**	3	0	0	3	50	50	100

Course Objective

The student should be made to

- Understand different types of sensors and actuators and their principles of operation at the micro scale level.
- Know the application of MEMS in different field of medicine.

Course Outcomes	At the end of the course, the student should be able to	Knowledge Level
	CO1: Discuss various MEMS fabrication techniques.	K2
	CO2: Explain different types of sensors and actuators and their principles of operation at the micro Scale level.	K2
	CO3: Explain about the micro fluidic systems.	K4
	CO4: Discuss various electrostatic and piezoelectric sensors and actuators.	K3
	CO5: Apply MEMS in different field of medicine.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	1		3		3			1					3	3	
CO 2	1		3		3			1					3	3	
CO 3	1		3		3			1					3	3	
CO 4	1		3		3			1					3	3	
CO 5							2					1	3		

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**MEMS MATERIALS AND FABRICATION**	Periods	**9**

Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.

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Unit – II	MECHANICAL AND THERMAL SENSORS AND ACTUATORS	Periods	9
Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermomechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever –microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor.			
Unit – III	**ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS**	Periods	**9**
Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.			
Unit – IV	**MICROFLUIDIC SYSTEMS**	Periods	**9**
Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system, micromixers.			
Unit – V	**APPLICATIONS OF BIOMEMS**	Periods	**9**
CAD for MEMS, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR),DNA sensor, MEMS based drug delivery, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor.			
		Total Periods	**45**

Text Books

1.	Tai Ran Hsu, —MEMS and Microsystems Design and Manufacture‖, Tata McGraw Hill Publishing Company, New Delhi, 2002. (Unit I, II, III & IV).
2.	Wanjun Wang, Stephen A.Soper, ‖BioMEMS: Technologies and Applications‖, CRC Press, New York, 2007.(Unit V).

References

1.	Marc J. Madou —Fundamentals of Microfabrication: the Science of Miniaturization‖, CRC Press,2002.
2.	Nadim Maluf, Kirt Williams. —An introduction to Microelectro Mechancial Systems Engineering‖, Second Edition, Artech House Inc, MA, 2004.
3.	Chang Liu,‘ Foundations of MEMS‘, Pearson Education International, New Jersey, USA,2006.
4.	Nitaigour Premchand Mahalik, —MEMS‖, Tata McGraw Hill Publishing Company, New Delhi, 2007.

E-Resources

1.	https://www.researchgate.net/publication/325135048_Implantable_Bio-MEMS_applications_A_review
2.	https://www.routledge.com/Microfluidics-and-Bio-MEMS-Devices-and-Applications/Santra/p/book/9789814800853
3.	https://nanohub.org/resources/27084/download/App_BioMEM_PK14_PG.pdf

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME02	**Nano Technology and Applications**	3	0	0	3	50	50	100
Course Objective	The student should be made to • Provide a broad view of the nascent field of nanoscience and nanotechnology to undergraduates. • Explore the basics of nanomaterial synthesis and characterization. • Introduce the applications of nanotechnology.							
Course Outcomes	At the end of the course, the student should be able to,					Knowledge Level		
	CO1: Describe the basic science behind the properties of materials.					K2		
	CO2: Interpret the creation, characterization, and manipulation of nanoscale materials.					K2		
	CO3: Comprehend the exciting applications of nanotechnology at the leading edge of scientific research.					K4		
	CO4: Describe about the properties of nanomaterial					K3		
	CO5: Apply their knowledge of nanotechnology to identify how they can be exploited for new applications.					K3		
Pre-requisites	-							

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3										1	3	3
CO 2	3	3	3										1	3	3
CO 3	3	3	2	2		2							1	3	3
CO 4	3	3	3										1	3	3
CO 5	3	3	2			2	2	2					1	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION TO NANOTECHNOLOGY**	Periods	**9**
Basic Structure of Nanoparticles- Kinetics in Nanostructured Materials- Zero dimensional, size and shape of nanoparticles; one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, bionano-particles.			
Unit – II	**FABRICATION AND CHARACTERIZATION OF NANOMATERIALS**	Periods	**9**
Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Buckyballs, Nanotubes); Gas, liquid, and solid –phase synthesis of nanomaterials; Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials.			
Unit – III	**PROPERTIES AND MEASUREMENT OF NANOMATERIALS**	Periods	**9**
Optical Properties: Absorption, Fluorescence, and Resonance; Methods for the measurement of nanomaterials; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging.			
Unit – IV	**NANO STRUCTURES**	Periods	**9**
Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots. Applications of nanostructures. Reinforcement in Ceramics, Drug delivery, Giant magnetoresistance, etc. Cells response to Nanostructures.			
Unit – V	**APPLICATIONS OF NANOTECHNOLOGY**	Periods	**9**
Nano electronics, Nanosensors, Nanotechnology in Diagnostics applications, Environmental and Agricultural Applications of nanotechnology, Nano technology for energy systems.			
		Total Periods	**45**

Text Books	
1.	Springer Handbook of Nanotechnology by Bharat Bhushan 2004.
2.	Encyclopedia of Nanotechnology - Hari Singh Nalwa 2004.
References	
1.	Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.
2.	Handbook of Nanophase and Nanostructured Materials (in four volumes), Eds: Z.L. Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003.
3.	Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.
E-Resources	
1.	https://www.iberdrola.com/innovation/nanotechnology-applications
2.	https://www.understandingnano.com/nanotech-applications.html
3.	https://www.nanowerk.com/nanotechnology-examples-and-applications.php

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME03	**Biomaterials and Artificial organs**	3	0	0	3	50	50	100

Course Objective	The student should be made to • Learn characteristics and classification of Biomaterials. • Understand different metals, ceramics and its nanomaterials characteristics as biomaterials. • Learn polymeric materials and combinations that could be used as a tissue replacement implants. • Have an overview of artificial organs & transplants. • Study about soft tissue replacement and hard tissue replacement.	
Course Outcomes	At the end of the course, the student should be able to	Knowledge Level
	CO1: Analyze different types of Biomaterials and its classification.	K2
	CO2: Identify different metals, ceramics and its nanomaterials characteristics as biomaterials.	K2
	CO3: Perform combinations of materials that could be used as a tissue replacement implant.	K4
	CO4: Will gain adequate knowledge about artificial organs & transplants	K3
	CO5: Will know the different types of soft tissue replacement and hard tissue replacement.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3											2	3	
CO 2	3	3	2										2	3	
CO 3	3	3	3	3									2	3	
CO 4	3	3	3	3									2	3	
CO 5	3	3	3										2	3	

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**INTRODUCTION TO BIO-MATERIALS**	Periods	**9**
Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, nanoscale phenomena.			
Unit – II	**METALLIC AND CERAMIC MATERIALS**	Periods	**9**
Metallic implants - Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bioinert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bioceramics.			
Unit – III	**POLYMERIC IMPLANT MATERIALS**	Periods	**9**
Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Case study of organ regeneration			
Unit – IV	**ARTIFICIAL ORGANS & TRANSPLANTS**	Periods	**9**
ARTIFICIAL ORGANS: Introduction, outlook for organ replacements, design consideration, evaluation process. **TRANSPLANTS**: Overview, Immunological considerations, Blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.			
Unit – V	**IMPLANTABLE MEDICAL DEVICES AND ORGANS**	Periods	**9**
Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.			
		Total Periods	**45**

Text Books

1.	Sujata V. Bhatt, "Biomaterials", Second Edition, Narosa Publishing House, 2005.
2.	Sreeram Ramakrishna, Murugan Ramalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, "*Biomaterials*: A Nano *Approach*", CRC Press, 2010.
3.	Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.

References

1.	Myer Kutz, "Standard Handbook of Biomedical Engineering & Design" McGraw Hill, 2003.
2.	J D Bronzino, Biomedical Engineering handbook Volume II, (CRC Press / IEEE Press), 2000.
3.	R S Khandpur, Handbook of Biomedical Instrumentation,Tata McGraw Hill, 2003.

E-Resources

1.	https://www.sciencedirect.com/book/9781845696535/biomaterials-for-artificial-organs
2.	https://pubs.acs.org/doi/10.1021/cen-v064n015.p030
3.	https://biomaterials.org.in/tibao/

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME04	**Medical Optics**	3	0	0	3	50	50	100

Course Objective	The student should be made to • The optical properties of the tissues and the interactions of light with tissues. • The instrumentation and components in Medical Optics. • The Medical Lasers and their applications. • The optical diagnostic applications. • The emerging optical diagnostic and therapeutic techniques.	
Course Outcomes	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Demonstrate knowledge of the fundamentals of optical properties of tissues.	K2
	CO2: Analyze the components of instrumentation in Medical Photonics and Configurations.	K2
	CO3: Describe surgical applications of lasers.	K4
	CO4: Describe photonics and its diagnostic applications.	K3
	CO5: Investigate emerging techniques in medical optics.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3		2	2									3	2	1
CO 2	2												3		
CO 3		3											3		
CO 4	3												3		
CO 5	3												3		

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**OPTICAL PROPERTIES OF THE TISSUES**	Periods	**9**
Fundamental Properties of light - Refraction, Reflection, Laws (Snell's law and Fresnel law) Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology, Laser tissue Interactions – Photo chemical, Photo thermal and Photo mechanical interactions, Fluorescence, Speckles, Photo ablative processes.			
Unit – II	**INSTRUMENTATION IN PHOTONICS**	Periods	**9**
Instrumentation for absorption, Scattering and emission measurements, Excitation light sources – high pressure arc lamps, LEDs, Lasers, Optical filters – Prism and Monochromators, Polarizers, Optical detectors – Single Channel and Multichannel detectors, Time resolved and phase resolved detection methods, Optical fibers – Total Internal Reflection.			
Unit – III	**SURGICAL THERAPEUTIC APPLICATIONS OF LASERS**	Periods	**9**
Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Tissue welding and Soldering.			
Unit – IV	**NON THERMAL DIAGNOSTIC APPLICATIONS**	Periods	**9**
Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and Speckle applications of lasers in biology and medicine			
Unit – V	**DIAGNOSTIC AND THERAPEUTIC TECHNIQUES**	Periods	**9**
Near field imaging of biological structures, *In vitro* clinical diagnostics, Phototherapy, Photodynamic therapy (PDT) - Principles and mechanisms - Oncological and non-oncological applications of PDT - Biostimulation effect – applications - Laser Safety Procedures.			
		Total Periods	**45**

Text Books	
1.	Tuan Vo Dirh, —Biomedical Photonics – Handbook‖, CRC Press, Bocaraton, 2014.
2.	Paras N. Prasad, —Introduction to Biophotonics‖, A. John Wiley and Sons, Inc. Publications, 2003.
References	
1.	Markolf H.Niemz, —Laser-Tissue Interaction Fundamentals and Applications‖, Springer, 2007.
2.	G.David Baxter —Therapeutic Lasers – Theory and practice‖, Churchill Livingstone publications Edition- 2001.
3.	Leon Goldman, M.D., & R.James Rockwell, Jr., —Lasers in Medicine‖, Gordon and Breach, Science Publishers Inc., 1975.
E-Resources	
1.	https://syntecoptics.com/medical-optics/
2.	https://link.springer.com/chapter/10.1007/978-3-319-31903-2_13
3.	https://en.wikipedia.org/wiki/Medical_optical_imaging

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME05	**Human Rights**	3	0	0	3	50	50	100
Course Objective	The students should be made to • Sensitize the Engineering students to various aspects of Human Rights.							

Course Outcomes	At the end of the course, the student should be able to	Knowledge Level
	CO1 : Engineering students will acquire the basic knowledge of human rights.	K2
	CO2: Understand about the Geneva convention.	K6
	CO3: explain six sigma.	K4
	CO4: explain Constitutional Provisions / Guarantees.	K3
	CO5: understand Human Rights of Disadvantaged People.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3									1	3	3	
CO 2	3	3	3									1	3	3	
CO 3	3	3	3									1	3	3	
CO 4	3	3	3									1	3		
CO 5	3	3	3									1	3		

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**INTRODUCTION TO HUMAN RIGHTS**	Periods	**9**

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

Unit – II	**EVOLUTION OF HUMAN RIGHTS**	Periods	**9**

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

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Unit – III	MANAGEMENT TOOLS	Periods	9
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types			
Unit – IV	**HUMAN RIGHTS IN INDIA**	Periods	**9**
Human Rights in India – Constitutional Provisions / Guarantees			
Unit – V	**HUMAN RIGHTS TO DIFFERENT ROLES OF PEOPLE**	Periods	**9**
Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements			
		Total Periods	**45**

Text Books	
1.	Lifting the Spirit: Human Rights and Freedom of Religion or Belief (Published by Human Rights Resource Center, University of Minnesota)
2.	Communication & Human Rights (Published by International Association for Media and Communication Research, Mexico, 2012)
References	
1.	Kapoor S.K., —Human Rights under International law and Indian Lawsǁ, Central Law Agency, Allahabad, 2014.
2.	Chandra U., —Human Rightsǁ, Allahabad Law Agency, Allahabad, 2014
3.	Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi
E-Resources	
1.	https://en.wikipedia.org/wiki/Human_rights
2.	https://www.britannica.com/topic/human-rights
3.	https://plato.stanford.edu/entries/rights-human/

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME06	**Total Quality Management**	3	0	0	3	50	50	100
Course Objective	The students should be made to • Facilitate the understanding of Quality Management principles and process.							
Course Outcomes	At the end of the course, the student should be able to							Knowledge Level
	CO1: Apply the tools and techniques of quality management to manufacturing and services processes.							K2
	CO2: Understand TQM principles.							K2
	CO3: Explain seven traditional tools.							K4
	CO4: understand various techniques of quality management.							K3
	CO5: explain various quality management system.							K3
Pre-requisites	-							

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**												**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs	
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3									1	3	3	
CO 2	3	3	3									1	3	3	
CO 3	3	3	3									1	3	3	
CO 4	3	3	3									1	3	3	
CO 5	3	3	3									1	3	3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**INTRODUCTION**	Periods	**9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

Unit – II	**TQM PRINCIPLES**	Periods	**9**

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement -

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Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.			
Unit – III	**TQM TOOLS AND TECHNIQUES I**	Periods	**9**
The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.			
Unit – IV	**TQM TOOLS AND TECHNIQUES II**	Periods	**9**
Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.			
Unit – V	**QUALITY MANAGEMENT SYSTEM**	Periods	**9**
Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.			
		Total Periods	**45**
Text Books			
1.	Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, —Total Quality Management‖, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.		
References			
1.	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8thEdition, First Indian Edition, Cengage Learning, 2012.		
2.	Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.		
3.	Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.		
E-Resources			
1.	https://asq.org/quality-resources/total-quality-management		
2.	https://www.investopedia.com/terms/t/total-quality-management-tqm.asp		
3.	https://en.wikipedia.org/wiki/Total_quality_management		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**		

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME07	**Foundation Skills in Integrated Product Development**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Understand the global trends and development methodologies of various types of products and services. • Conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems. • Understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification. • Understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics. • Develop documentation, test specifications and coordinate with various teams to validate and sustain up to the eol (end of life) support activities for engineering customer.

Course Outcomes	At the end of the course, the student should be able to	Knowledge Level
	CO1:.Define, formulate and analyze a problem.	K2
	CO2: Solve specific problems independently or as part of a team.	K6
	CO3: Gain knowledge of the Innovation & Product Development process in the Business Context.	K4
	CO4: Work independently as well as in teams.	K3
	CO5: Manage a project from start to finish .	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2 – Medium, 1 - Weak													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2					2					3	2	
CO 2	3	3	2	2				2		2			3		2
CO 3	3	3	2	2									3	2	
CO 4	3	2	2	2				2		2			3		2
CO 5	3	2	2							2			3	2	

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**FUNDAMENTALS OF PRODUCT DEVELOPMENT**	Periods	**9**
Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.			
Unit – II	**REQUIREMENTS AND SYSTEM DESIGN**	Periods	**9**
Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.			
Unit – III	**DESIGN AND TESTING**	Periods	**9**
Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation.			
Unit – IV	**SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT**	Periods	**9**
Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal.			
Unit – V	**BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY**	Periods	**9**
The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.			
		Total Periods	**45**

Text Books

1.	Book specially prepared by NASSCOM as per the MoU.
2.	Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3.	John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

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References	
1.	Hiriyappa B, —Corporate Strategy – Managing the Businessǁ, Author House, 2013.
2.	Peter F Drucker, —People and Performanceǁ, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3.	Vinod Kumar Garg and Venkita Krishnan N K, —Enterprise Resource Planning – Conceptsǁ, Second Edition, Prentice Hall, 2003.
E-Resources	
1.	https://www.academia.edu/33089267/FOUNDATION_SKILLS_IN_INTEGRATED_PRODUCT_DEVELOPMENT

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**V**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME08	**Artificial organs and Implants**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Have an overview of artificial organs & transplants. • Describe the principles of implant design with a case study. • Explain the implant design parameters and solution in use. • Study about various blood interfacing implants. • Study about soft tissue replacement and hard tissue replacement.	
Course Outcomes	At the end of the course, the student should be able to	Knowledge Level
	CO1: Gain adequate knowledge about artificial organs & transplants.	K2
	CO2: Get clear idea about implant design and its parameters and solution.	K6
	CO3: Have in-depth knowledge about blood interfacing implants.	K4
	CO4: Explain different types of soft tissue replacement and hard tissue replacement.	K3
	CO5: To acquire adequate knowledge about implantable devices.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3									2	3	3	
CO 2	3	3	2									2	3	3	
CO 3	3	3	3	3								2	3	3	
CO 4	3	3	3	3								2	3	3	
CO 5	3	3	3									2	3	3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**ARTIFICIAL ORGANS & TRANSPLANTS**	Periods	**9**
ARTIFICIAL ORGANS:-Introduction, outlook for organ replacements, design consideration, evaluation process. **TRANSPLANTS**:-Overview, Immunological considerations, Blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.			
Unit – II	**PRINCIPLES OF IMPLANT DESIGN**	Periods	**9**
Principles of implant design, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration.			
Unit – III	**IMPLANT DESIGN PARAMETERS AND ITS SOLUTION**	Periods	**9**
Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration.			
Unit – IV	**BLOOD INTERFACING IMPLANTS**	Periods	**9**
Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.			
Unit – V	**IMPLANTABLE MEDICAL DEVICES AND ORGANS**	Periods	**9**
Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.			
		Total Periods	**45**
Text Books			
1.	Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 1976.		
2.	Park J.B., —Biomaterials Science and Engineering‖, Plenum Press, 1984.		
References			
1.	J D Bronzino, Biomedical Engineering handbook Volume II, (CRC Press / IEEE Press), 2000.		
2.	R S Khandpur, Handbook of Biomedical Instrumentation,Tata McGraw Hill, 2003.		
3.	Joon B Park, Biomaterials – An Introduction, Plenum press, New York, 1992.		
E-Resources			
1.	https://pubs.acs.org/doi/10.1021/cen-v064n015.p030		

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
(Autonomous Institution, Affiliated to Anna University ,Chennai)
Elayampalayam, Tiruchengode – 637 205

Programme	B.E.	Programme Code	106	Regulation	2019
Department	BIOMEDICAL ENGINEERING			Semester	V

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BMOE1	Biotelemetry	3	0	0	3	50	50	100

Course Objective

The student should be made:

- To introduce the concept of biomedical telemetry system.
- To develop the understanding of the signal communication and security issues in biomedical telemetry.

Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Discuss the basic concepts of biomedical telemetry system.	K2,K4
	CO2: Explain the various techniques involved in biosensors.	K3,K4
	CO3: Recognize the various communication methods involved in biomedical telemetry system.	K3,K5
	CO4: Discuss the importance of patient's data privacy and the security issues in biomedical telemetry system.	K2,K5
	CO5: Apply the biomedical telemetry principles in various clinical applications.	K1,K3

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3										3	2	
CO 2	3				2								3	3	
CO 3	3		2										3	2	
CO 4	3	3											3	2	
CO 5	3				2								3	3	

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

Indirect

1. Course - end survey

Content of the syllabus

Unit – I	BASIC CONCEPTS	Periods	9

Introduction to biomedical telemetry - Typical Biomedical Telemetry System- Challenges in Biomedical Telemetry - Design Considerations of Biomedical Telemetry Device- Energy Transfer Types - Architecture of Inductively Coupled Biomedical Telemetry Devices - Data Transmission Methods - Safety Issues.

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Unit – II	ACQUISITION OF DATA	Periods	9
Sensing Principles for Biomedical Telemetry - Biosensor Structure - Electrochemical Biosensors -Optical Biosensors - Thermal/Calorimetric Biosensors - Piezoelectric Biosensors - Other Types of Biosensors, Sensing Technologies- Noninvasive Sensors and Interfaces - Invasive and Implantable Sensors, Power Issues.			
Unit – III	**PROPAGATION AND COMMUNICATION**	Periods	**9**
Electrical Properties of Human Body Tissues, Inductive Coupling - Induction Principles - Wireless Power Transmission - Inductive Coupling for Biomedical Telemetry - Inductive Data Transmission - Broader Applications, Antennas and RF Communication — Introduction - On-Body Antennas - Implantable Antennas - Ingestible Antennas, Intrabody Communication Transmission Methods			
Unit – IV	**SECURITY AND PRIVACY IN BIOMEDICAL TELEMETRY**	Periods	**9**
Digital Security- Wearable Health Monitoring Systems (WHMS) Platform - Processing of Physiological Data- Secure Information Exchange, Theory and Applications of Biomedical Telemetry - Integration of Biomedical Telemetry with Telemedicine, Safety Issues - Operational Safety - Product and Device Hazards - Patient and Clinical Safety - Human Factor and Use Issues - Electromagnetic Compatibility and Interference Issues - Applicable Guidelines -Occupational Safety.			
Unit – V	**APPLICATIONS OF BIOMEDICAL TELEMETRY**	Periods	**9**
Clinical Applications of Body Sensor Networks - Wearable Health Care System - Epidermal Sensor Paradigm: Inner Layer Tissue Monitoring - Implantable Health Care System Paradigm -Wireless Capsule Endoscopy - Diabetes Management.			
		Total Periods	**45**

Text Books

1.	Konstantina S. N ikita, "Handbook of Biomedical Telemetry (IEEE Press Series on Biomedical Engineering), 1st Edition, Wiley, 2014.

References

1.	Patranabis D, "Telemetry Principles", TMH, New Delhi, 1999.
2.	John G Webster, "Encyclopedia of Medical devices and Instrumentation — Von", John Wiley and Sons, 1988.

E-Resources

1.	http://nptel.iitg.ernet.in/courses/Elec_EngWIIT%20Bombay/Electrical%20and%20Electronic%20Measurements.html, "Electrical Measurements and Instrumentation", Prof. T. Anjaneyulu, Indian Institute of Technology, Bombay.
2.	http://nptel.ac. inisyllabus/syllabus.php?subjectId=117107035, "Advanced Antenna Theory", Dr.Amalendu Patnaik, IIT Roorkee.

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Elayampalayam, Tiruchengode – 637 205

Programme	B.E.	Programme Code	106	Regulation	2019
Department	BIOMEDICAL ENGINEERING			Semester	V

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BMOE2	Virtual Instrumentation	3	1	0	4	50	50	100

Course Objective

The student should be made to,

- Impart the knowledge on basics, programming techniques, data acquisition concepts of virtual instrumentation and its uses for different applications.

Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Explain the basics concepts in virtual instrumentation.	K2,K4
	CO2:Demonstrate the programming concepts in virtual instrumentation.	K3,K4
	CO3: Develop an ability for programming in LabVIEW using loops and structures.	K3,K5
	CO4: Discuss how to configure the related hardware like DAQ and transducers.	K2,K5
	CO5: Apply virtual instrumentation concept for various applications.	K1,K3

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	1		1										3		3
CO 2	1		3										2		3
CO 3	1		3		3								2		3
CO 4													3	2	3
CO 5	1				3								3	3	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

Indirect
1. Course - end survey

Content of the syllabus

Unit – I	BASICS OF VIRTUAL INSTRUMENTATION	Periods	9

Introduction- Virtual Instrument versus Traditional Instrument, Advantages, Comparison of Graphical Programming and Textual Programming-LabVIEW environment: Front Panel, Block Diagram, Data Flow techniques.

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Unit - II	PROGRAMMING PRINCIPLES	Periods	9
Creating simple VI- Data types-Numeric, String, Boolean-Mechanical Operation of Boolean, Arrays, Clusters, Waveforms graphs and waveform charts - Array Functions- Cluster Functions- Debugging Techniques, Documentation, Context Help Window-Sub VI-Creation.			
Unit – III	**LOOPS AND STRUCTURES**	Periods	**9**
FOR — WHILE loop - Case, Sequence, event structures- Formula nodes- local and global variables.			
Unit - IV	**DATA ACQUISITION SYSTEM**	Periods	**9**
Instrument control – GPIB – VISA - instrument drivers-serial port communication. Data Acquisition: Review of Transducer and Signal conditioning, DAQ. Hardware - Analog inputs - Analog outputs-Digital I/O- DAQ assistant and configurations.			
Unit – V	**APPLICATIONS OF VIRTUAL INSTRUMENTATION**	Periods	**9**
Signal Processing and Analysis, Image acquisition and processing - Biomedical Startup Kit - Motion control - Control Design and Simulation Tools - Simulation Interface Tool kit - Embedded Module - GSD Applications.			
		Total Periods	**45**

Text Books

1.	Jovitha Jerome "Virtual Instrumentation using labview" Prentice Hall of India, NewDelhi, 2010.

References

1.	Gary W.Johnson and Richard Jennings, "LabVIEW Graphical Programming", McGraw Hill, 4th Edition, New York, 2011.
2.	Jeffrey Travis and Jim Kring, "LabVIEW for everyone", 3rd edition, Dorling Kindersley, 2009.

E-Resources

1.	http://www.n com/academ ic/students/learn- labview/
2.	http://www.ni.com/white-paper/3536/en/

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Elayampalayam, Tiruchengode – 637 205

Programme	B.E.	Programme Code	106	Regulation	2019
Department	BIOMEDICAL ENGINEERING			Semester	V

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BMOE3	Hospital Waste Management	3	0	0	3	50	50	100

Course Objective

The student should be made to
- Understand the hazardous materials used in hospital and its impact on health.
- Understand various waste disposal procedures and management.

Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Analyse various hazards, accidents and its control.	K2,K4
	CO2: Design waste disposal procedures for different biowastes.	K3,K4
	CO3: Categorise different biowastes based on its properties.	K3,K5
	CO4: Design different safety facility in hospitals.	K2,K5
	CO5: Propose various regulations and safety norms.	K1,K3

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1													3	2	1
CO 2						3							3	3	
CO 3						3			2			3	3	2	
CO 4		1	1				1	1					3	2	
CO 5	2	2				2						3	3	3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS**	Periods	**9**
Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education, and Training.			
Unit – II	**BIOMEDICAL WASTE MANAGEMENT**	Periods	**9**
Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labelling, waste handling, collection, storage and transportation, treatment and disposal.			
Unit – III	**HAZARDOUS MATERIALS**	Periods	**9**
Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.			
Unit – IV	**FACILITY SAFETY**	Periods	**9**
Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.			
Unit – V	**INFECTION CONTROL, PREVENTION AND PATIENT SAFETY**	Periods	**9**
Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Blood borne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.			
		Total Periods	**45**

Text Books	
1.	Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014).
2.	Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012).
References	
1.	R.C.Goyal, —Hospital Administration and Human Resource Managementl, PHI – Fourth Edition, 2006
2.	V.J. Landrum, —Medical Waste Management and disposall, Elsevier, 1991
E-Resources	
1.	https://applications.emro.who.int/imemrf/Professional_Med_J_Q/Professional_Med_J_Q_2013_20_6_988_994.pdf

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19EC416	**DIGITAL SIGNAL PROCESSING LABORATORY**	0	0	2	1	50	50	100

Course Objective

The student should be made to

- Perform basic signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation and Frequency analysis in MATLAB
- Implement FIR and IIR filters in MATLAB and DSP Processor.
- Study the architecture of DSP processor.
- Design a DSP system to demonstrate the Multi-rate and Adaptive signal processing concepts.

Course Outcome	At the end of the course, the student should be able to	Knowledge Level
	CO1: Carryout basic signal processing operations.	K4
	CO2: Demonstrate their abilities towards MATLAB based implementation of various DSP systems.	K4
	CO3: Analyze the architecture of a DSP Processor.	K2
	CO4: Design and Implement the FIR and IIR Filters in DSP Processor for performing filtering operation over real-time signals.	K3
	CO5: Design a DSP system for various applications of DSP.	K4

Pre-requisites Signals and Systems & Digital Signal Processing.

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	2	2	2	1				2	3	3		2
CO 2	3	3	2	2	2	2	1				2	2	3		2
CO 3	3	3	2	2	2	2	1				2	2	3		2
CO 4	3	2	2	2	2	2	1				2	2	3		2
CO 5	3	2	2	2	2	2	1				2	2	3		2

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Course Assessment Methods

Direct
1. Prelab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

LIST OF EXPERIMENTS: MATLAB Experiments:

1. Generation of different types of Signals and IDFT.
2. Computation of DFT of signal input sequence.
3. Design and Simulation of Linear and Circular Convolution.
4. Design and Simulation of FIR (LPF, HPF, BPF&BSF) filters.
5. Design and Simulation of IIR (LPF, HPF, BPF&BSF) filters.
6. Design and Simulation of sampling and sampling rate conversion.

DSP PROCESSOR Experiments:

7. Study of architecture of Digital Signal Processor
8. Generation of Signals.
9. Computation of a DFT of a signal.
10. Design and Implementation of Linear and Circular Convolution.
11. Design and Implementation of FIR filters.
12. Design and Implementation of IIR filters.
13. Implement an Up-sampling and Down-sampling operation in DSP Processor

Total Periods	**45**

Suggested Lab Manuals:

1. Vinay K.Ingle , John G Proakis, "Digital Signal Processing using MATLAB " ,3rd Edition,CENGAGE Learning.
2. Sophocles J. Orfanidis, "DSP Lab Manual", RUTGERS UNIVERSITY, The State University of New Jersey.

E-Resources

1. http://research.iaun.ac.ir/pd/naghsh/pdfs/UploadFile_6417.pdf
2. https://en.wikipedia.org/wiki/Digital_signal_processor

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM511	**BIOMEDICAL INSTRUMENTATION LABORATORY**	0	0	2	1	50	50	100

Course Objective	The student should be made to, • Study the characteristics of sensors, signal conditioning circuits and their biomedical applications.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: To design the measurement system for various biomedical applications.	K4
	CO2: Identification and enumeration of pulse rate.	K4
	CO3: Have a sound knowledge of Blood pressure measurement.	K2
	CO4: Enumeration of various amplifiers in Biomedical systems.	K3
	CO5: Analysis of pH, Blood flow and Bio-signals.	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3	3		3					1			3	3
CO 2	3	3	3	3		3					1			3	3
CO 3	3	3	3	3		3					1			3	3
CO 4	3	3	3	3		3					1			3	3
CO 5	3	3	3	3		3					1			3	3

Course Assessment Methods

Direct
1. Pre lab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus

SUGGESTED LIST OF EXPERIMENTS:

1. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable IC's
2. Design of ECG Amplifiers with appropriate filter to remove power line and other artifacts.
3. Design of EMG amplifier
4. Design a suitable circuit to detect QRS complex and measure heart rate
5. Design of frontal EEG amplifier
6. Design a right leg driven ECG amplifier.
7. Design and study the characteristics of optical Isolation amplifier
8. Design a Multiplexer and Demultiplexer for any two biosignals.
9. Measurement of pulse-rate using Photo transducer.
10. Measurement of pH and conductivity.
11. Measurement of blood pressure using sphygmomanometer.
12. Design a PCB layout for any bio amplifier using suitable software tool.
13. Measurement of Blood Glucose using glucometer.

Total Periods	**45**

Suggested Lab Manuals:

1. Maria Teresa, Restivo Fernando, Gomes de Almeida, Maria de Fátima, Chouzal Joaquim, Gabriel Mendes António Mendes Lopese-book on "Laboratories of Instrumentation for Measurement".

E-Resources

1. https://www.elsevier.com/books/principles-of-electronic-instrumentation/de-sa/978-0-08-093469-3
2. http://www.ifm.liu.se/courses
3. https://www.sciencedirect.com/topics/physics-and-astronomy

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**V**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EN503	**COMMUNICATION SKILLS LABORATORY**	0	0	3	1	100	-	100
Course Objective	The student should be made to, • Equip with effective Soft skills in English. • Enhance them with intrapersonal skills. • Effective management of time and stress.							
Course Outcome	At the end of the course, the student should be able to,					Knowledge Level		
	CO1: Able to communicate, present, describe and discuss fluently in English.					K4		
	CO2: Equipped for an easy transition from studying to working atmosphere.					K4		
	CO3: Accomplished with planning and corporate Managerial skills.					K2		
	CO4: To attain professional correspondence and execute the same in professional manner.					K3		
	CO5: To employ the professional needs and accomplishments at global standards.					K4		
Pre-requisites	-							

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**												**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1						2			3	3		3		2	
CO 2						2			2	3		3		2	
CO 3						2			2	2		3		1	
CO 4						2			3	3		3		2	
CO 5						2			3	3		3		3	

Course Assessment Methods

Direct
1. Prelab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus

English Language Proficiency: Listening Comprehension, Reading Comprehension, Common Errors in English, Diction and its usage, Framing sentences – Idiomatic Expressions.

Resume – Structuring and Drafting the resume – Cover letter- Writing Professional Letters.

Group Discussion: Introduction – Topic Analysis – Thematic Expressions-Objective and content of discussion – Persuasion – Discussion – Controlling Emotions - Presentation of the group – Offering support – Use of functional Language - Summary and conclusion

Presentation skills: Making Self Introduction effectively-Elements of effective presentation – Structure of presentation - Presentation tools – Voice Modulation – Audience analysis - Body language – Accents analysis – Stylistics.

Soft Skills: Introduction - Change in Today's Workplace: Soft Skills as a Competitive Weapon - Antiquity of Soft Skills - Classification of Soft skills - Ability to work as a team - Innovation, Creativity and Lateral thinking – Flexibility - Personality Traits and Soft Skills for future Career Advancement-Personality and Soft Skills for career growth- Time management.

Total Periods	**45**

Suggested Lab Manuals:

1. Anderson, P.V, Technical Communication, Thomson Wadsworth, Sixth Edition, New Delhi, 2007.
2. John Seely, The Oxford Guide to Writing and Speaking, Oxford University Press, New Delhi, 2004.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**			Regulation		**2019**
Department	**BIOMEDICAL ENGINEERING**					Semester		**V**
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19MCTY5	**Logical Reasoning**	3	0	0	-	100	-	100

Content of the syllabus

Unit – I	**VERBAL REASONING**	Periods	**6**

Coding – Decoding(Letter Coding, Direct Letter Coding, Number/Symbol Coding, Deciphering Message – Word coding and Numeral coding, Substitution Coding, Crypt coding – crypt addition, subtraction, Information Arrangement Coding) , Analogy (Direct and Simple Analogy, Completing the Analogues pair, Choosing the Analogues pair, Choosing the similar word, Number Analogy, Alphabet Analogy), Classification(Choosing the odd words, Choosing the odd pair of words, Choosing the odd letter group, Choosing the odd number and odd pair of numbers), Alphabet Test(Arrangement according to dictionary, Alpha-Numeric sequence, Letter word problems, Rule detection), Word Formation (Using letters from a given word, By unscrambling words)

Unit - II	**SITTING ARRANGEMENT & SENSE TEST**	Periods	**6**

Sitting Arrangement (Arrangement in a line, Arrangement around of a circle, square and rectangle, Arrangement around pentagonal and hexagonal, **Direction Sense Test**[(Main, Cardinal and Shortest Direction)Final Detection, Displacement, Direction and Displacement], **Number, Ranking, Time sequence Test** (Number Test, Ranking Test, Time Sequence Test), Puzzles (Based on classification, Based on placing and comparison, Family Based problems)

Unit – III	**NUMBER AND LETTER SERIES**	Periods	**6**

Number and Letter Series[(**Number Series:** To find a missing term, Find the number that does not follow the pattern, Miscellaneous pattern of the series (Based on addition / subtraction of consecutive odd / even no's, Based on addition / subtraction of prime numbers, Multiplication and Division, Based on addition / subtraction of squares of natural numbers, Based on addition / subtraction of cubes of natural numbers) , Letter Series (Alphabet Series, Continuous pattern of series)], **Inserting the missing character, Age, Blood** (Jumbled up descriptions, Relation puzzles, Coded Relations), **Clock and calendar** (Mathematical operations and Notations- Problem of solving by substitution, Interchanging signs and numbers, Deriving the appropriate conclusions), **Logical order of words, Clerical aptitude** (Question based on address, Question based on issues)

Unit - IV	**LOGICAL AND ANALYTICAL REASONING**	Periods	**6**

Logical venn diagrams (Universal positive, Universal Negative, Universal Affirmative or Negative, Miscellaneous, Geometrical Figures on Venn Diagrams), **Eligibility test, Syllogisms, Statement and Assumptions, Statement and Conclusions, Statement and Arguments, Statement and Course of Action, Verification of Truth of the Statement, Data Sufficiency.**

Unit – V	**DATA INTERPRETATION &FLOW CHART**	Periods	**6**

Input – Output (Shifting, Arranging),**Data Interpretation** (Table chart, Bar chart, Pie chart, Miscellaneous chart, Mixed chart), Cube(no of sided painted, Full cube, cutting cube), **Flow chart** (Description flow chart, Value updating flow chart), **Quantitative reasoning, Logical deduction, Deductive reasoning, Binary logic**

	Total Periods	**30**

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Text Books	
1.	How to crack Test of Reasoning- Jai kishan and Prem kishan – arihant Publication
References	
1.	How to prepare logical reasoning for CAT- Arun Sharama – Mc Graw Hill Publication

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC519	**Microprocessor and Microcontroller**	3	0	0	3	50	50	100

Course Objective

The student should be made to,

- Study the Architecture of 8085 and 8086 microprocessor.
- Learn the design aspects of I/O and Memory Interfacing circuits.
- Study the addressing modes and instruction set of 8086 and 8051
- Study the Architecture of 8051 microcontroller.
- Develop skill in simple program writing for 8086 and 8051 applications

Course Outcome	At the end of the course, the student should be able to	Knowledge level
	CO1: Interpret and execute programs based on 8085 and 8086 microprocessor	K2
	CO2: Interpret 8086 signals and bus operations	K2
	CO3: Design and interface I/O circuits	K3
	CO4: Design and implement 8051 microcontroller based systems	K3
	CO5: Summarize applications using microprocessor / microcontroller	K2

Pre-requisites -

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**												**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	2	2		2			2	2		2			2	3	
CO 2	2	3		3			2	2		2			3	3	
CO 3	2	3		2			3	3		3			3	2	
CO 4	3	2		3			2	2		2			2	2	
CO 5	3	2		2			2	2		2			2	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**8- BIT and 16 - BIT MICROPROCESSOR.**	Periods	**9**
8085 Architecture, Instruction set, Addressing modes, Interrupts, Timing diagrams, Memory and I/O interfacing. 8086 Architecture, Instruction set and programming, Minimum and Maximum mode configurations.			
Unit – II	**8086 SYSTEM BUS STRUCTURE**	Periods	**9**
8086 signals – Basic configurations – System bus timing –System design using 8086 – IO programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.			
Unit – III	**I/O INTERFACING**	Periods	**9**
Memory Interfacing and I/O interfacing – Parallel communication interface – Serial communication interface– D/A and A/D Interface – Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.			
Unit – IV	**MICROCONTROLLER**	Periods	**9**
Architecture of 8051 – Special Function Registers(SFRs) – I/O Pins Ports and Circuits – Instruction set – Addressing modes – Assembly language programming.			
Unit – V	**INTERFACING MICROCONTROLLER**	Periods	**9**
Programming 8051 Timers – Serial Port Programming – Interrupts Programming – LCD & Keyboard Interfacing – DC, DAC & Sensor Interfacing – External Memory Interface- Stepper Motor and Waveform generation.			
		Total Periods	**45**

Text Books	
1.	Doughlas V.Hall, "Microprocessors and Interfacing, Programming and Hardware", TMH, 2012.
2.	A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGrawHill, 2012.
References	
1.	Yu-Cheng Liu, Glenn A. Gibson, "Microcomputer Systems: The 8086 / 8088 Family – Architecture, Programming and Design", 2nd Edition, Prentice Hall of India, 2014.
2.	Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", 2nd Edition, Pearson Education, 2011.
3.	Krishna Kant, "Microprocessor and Microcontroller Architecture, programming and system design using 8085, 8086, 8051 and 8096'', PHI, 2007, 7th Reprint, 2015.
4.	Kenneth J. Ayala., "The 8051 Microcontroller, 3rd Edition, Thompson Delmar Learning'', 2012.
5.	A.K. Ray, K.M. Bhurchandi, "Advanced Microprocessor and Peripherals'', Tata McGraw-Hill, 2nd Edition, 2010.
E-Resources	
1.	https://www.worldcat.org/title/microprocessors-and-interfacing-programming-and-hardware/oclc/611374608
2.	https://pdfcoffee.com/ak-ray-and-km-bhurchandi-advanced-microprocessors-and-peripherals-3e-tata-mcgraw-hill-2012pdf-pdf-free.html
3.	https://pdfcoffee.com/1pdfnetmicrocomputer-systems-the-8086-8088-family-architecture-pdf-pdf-free.html
4.	https://www.sanfoundry.com/microcontroller-mcqs-introduction/

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM612	**Medical Image Processing**	3	0	0	3	50	50	100

Course Objective

The student should be made to,

- Become familiar with digital image fundamentals.
- Get exposed to simple image enhancement techniques and restoration techniques.
- Learn concepts of various image segmentation methods and analysis in medical images.
- Study the concepts of wavelets and image compression techniques.
- Become familiar with reconstruction techniques applied to various medical Images.

Course Outcome

At the end of the course, the student should be able to,	Knowledge level
CO1: Understand the image fundamentals and mathematical transforms necessary for image processing.	K1
CO2: Describe the various image enhancement and image restoration techniques.	K2
CO3: Apply various image segmentation methods and analysis in medical images.	K3
CO4: Illustrate the basic concepts of wavelets and image compression techniques.	K4
CO5: Explain the different types of reconstruction techniques applied to various medical Images.	K5

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	3	3		3			1	2		2	2	2	3	3
CO 2	3	3	3	1	3			1	2		2	2	2	3	3
CO 3	3	3	2	2				1	2		3	2	2	3	3
CO 4	3	2	2	2				1	2		3	3	2	3	3
CO 5	3	2	2					1	2		3	3	2	3	3

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

Indirect

1. Course - end survey

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Content of the syllabus			
Unit – I	**Digital Image Fundamentals and 2d Image Transforms**	Periods	**9**
Elements of visual perception, Image sampling -2D sampling theory and its reconstruction, quantization-optimal quantizer, uniform quantizer, different types of quantization techniques, Neighborhood pixel relationships, basic imag operations arithmetic, logical and morphological, Image transform- 2D DFT, discrete cosine, haar and hadamard transforms, KL transform.			
Unit – II	**Image Enhancement and Image Restoration**	Periods	**9**
Basic gray level transformation, Histogram equalization and histogram matching, Image smoothening, Image sharpening, both spatial and frequency domain, Color image Processing color models, Pseudo color image processing, Image degradation models, restoration - mean filter, order statistics filter, adaptive filters.			
Unit – III	**Image Segmentation and Analysis**	Periods	**9**
Edge detection- Marr Hidreth edge detector,canny edge detector, Thresholding-foundation, basic global thresholding, Segmentation-amplitude segmentation methods, clustering segmentation methods , region based segmentation, watershed segmentation algorithm, Shape analysis- topological attributes, distance, perimeter and area measurements.			
Unit – IV	**Basic Morphological Operations and Image Compression**	Periods	**9**
Erosion and dilations, opening and closing, hit or miss transformations, Image compression fundamentals ,basic image compression methods, run length, Huffman, arithmetic, transform and lossy and lossless predictive coding, Digital image watermarking.			
Unit – V	**Reconstruction of Medical Images**	Periods	**9**
Image reconstruction from projections, Radon transforms, inverse radon transform, Filter back projection algorithm, Fourier reconstruction of MRI Images, Reconstruction of PET, SPECT and fMRI images.			
		Total Periods	**45**

Text Books	
1.	Rafael C., Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education Asia, 3rd edition, 2007.
2.	Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 3rd edition, 2001.
References	
1.	William K. Pratt, "Digital Image Processing",John Wiley, NJ, 4thedition, 2007.
2.	Albert Macouski, "Medical Imaging systems", Prentice Hall, New Jersey,2nd edition,1997.
3.	Medical image processing lab manual.
E-Resources	
1.	https://www.synopsys.com/glossary/what-is-medical-image-processing.html
2.	https://www.powershow.com/view/11c00dNGIwO/Medical_Image_Processing_powerpoint_ppt_presentation.
3.	https://www.academia.edu/31641513/Medical_Image_Processing.

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BM613	**Diagnostic And Therapeutic Equipment-I**	3	0	0	3	50	50	100

Course Objective

The student should be made to

- Understand the devices for measurement of parameters related to cardiology.
- Illustrate the recording and measurement of EEG.
- Demonstrate EMG recording unit and its uses.
- Explain diagnostic and therapeutic devices related to respiratory parameters.
- Understand the various sensory measurements that hold clinical importance.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Describe the working and recording setup of all basic cardiac equipment.	K1
	CO2: Understand the working and recording of all basic neurological equipment's.	K2
	CO3: Discuss the recording of diagnostic and therapeutic equipment's related to EMG.	K3
	CO4: Explain about measurements of parameters related to respiratory system.	K4
	CO5: Describe the measurement techniques of sensory responses.	K5
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3	3	2	3	1	1	2	1	1	1	3	3	2
CO 2	3	2	3	2	2	3	1	1	1	1	1	1	2	3	2
CO 3	3	2	3	1	2	3	1	1	1	1	1	1	2	3	2
CO 4	3	2	3	1	2	3	1	1	1	1	1	1	1	3	2
CO 5	3	2	3	1	2	3	1	1	1	1	1	1	1	3	2

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**CARDIAC EQUIPMENT**	Periods	**9**
Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External, Defibrillator Protection Circuit, Cardiac ablation catheter.			
Unit – II	**NEUROLOGICAL EQUIPMENT**	Periods	**9**
Clinical significance of EEG, Multi-channel EEG recording system, Epilepsy, Evoked Potential– Visual, Auditory and Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation. EEG system maintenance and troubleshooting.			
Unit – III	**MUSCULAR AND BIOMECHANICAL MEASUREMENTS**	Periods	**9**
Recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation. Static Measurement – Load Cell, Pedobarograph. Dynamic Measurement – Velocity, Acceleration, GAIT, Limb position.			
Unit – IV	**RESPIRATORY MEASUREMENT SYSTEM**	Periods	**9**
Instrumentation for measuring the mechanics of breathing – Spirometer -Lung Volume and vital capacity, measurements of residual volume, Pneumotachometer – Airway resistance measurement, Whole body Plethysmograph, Intra-Alveolar and Thoracic pressure measurements, Apnoea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.			
Unit – V	**SENSORY MEASUREMENT**	Periods	**9**
Psychophysiological Measurements – polygraph, basal skin resistance (BSR), galvanic skin resistance (GSR), Sensory responses - Audiometer-Pure tone, Speech, Eye Tonometer, Applanation Tonometer, slit lamp, auto refractometer.			
		Total Periods	**45**

Text Books	
1.	John G. Webster, —Medical Instrumentation Application and Design‖, 4th edition, Wiley India PvtLtd,New Delhi, 2015.
2.	Joseph J. Carr and John M. Brown, —Introduction to Biomedical Equipment Technology‖, Pearson education, 2012.
References	
1.	Myer Kutz, —Standard Handbook of Biomedical Engineering & Design‖, McGraw Hill, 2003.
2.	L.A Geddes and L.E.Baker, —Principles of Applied Biomedical Instrumentation‖, 3rd Edition, 2008
3.	Leslie Cromwell, —Biomedical Instrumentation and Measurement‖, Pearson Education, New Delhi, 2007.
4.	Antony Y.K.Chan,‖Biomedical Device Technology, Principles and design‖, Charles Thomas Publisher Ltd, Illinois, USA, 2008.
5.	B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, —Medical Physics and Biomedical Engineering‖, 2nd Edition, IOP Publishers. 2001.
E-Resources	
1.	https://www.vignan.ac.in/subjectsnew/16BM306.pdf
2.	https://groups.google.com/g/56zbivyfn/c/VAiB53Zb-vY?pli=1
3.	https://www.youtube.com/watch?v=_SRzREExXZo

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME09	**Telehealth Technology**	3	0	0	3	50	50	100

Course Objective

The student should be made to,

- Learn the key principles for telemedicine and health .
- Understand telemedical technology.
- Know telemedical standards, mobile telemedicine and it applications.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Apply multimedia technologies in telemedicine.	K2,K4
	CO2: Explain protocols behind encryption techniques for secure transmission of data .	K3,K4
	CO3: Apply telehealth in healthcare.	K3,K5
	CO4: Explain the ethical and legal aspects of telemedicine.	K2,K5
	CO5: Explain picture archiving and communication system.	K1,K3
Pre-requisites	-	

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO 1	3	2	3	1	2	2		2	3	2	1		2		3
CO 2	3	2	3	1	2	2		2	3	2	1		2		
CO 3	3	3	2	1	2	2		2	3	2	1		2		
CO 4	3	3	3	1	3	2		2	3	2	1		2		
CO 5	3	3	3	1	2	2		2	3	2	1		2		

Course Assessment Methods

Direct

1. Continuous Assessment Test I, II & III
2. Assignment
3. End-Semester examinations

Indirect

1. Course - end survey

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Content of the syllabus			
Unit – I	**FUNDAMENTALS OF TELEMEDICINE**	Periods	**9**
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.			
Unit – II	**TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE**	Periods	**9**
Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.			
Unit – III	**ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE**	Periods	**9**
Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues, intellectual property rights.			
Unit – IV	**PICTURE ARCHIVING AND COMMUNICATION SYSTEM**	Periods	**9**
Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.			
Unit – V	**APPLICATIONS OF TELEMEDICINE**	Periods	**9**
Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health and Cyber Medicine.			
		Total Periods	**45**

Text Books	
1.	Norris A C, —Essentials of Telemedicine and Telecare‖, John Wiley, New York, 2002.
2.	H K Huang, —PACS and Imaging Informatics: Basic Principles and Applications‖ Wiley, New Jersey, 2010.
References	
1.	Olga Ferrer Roca, Marcelo Sosa Iudicissa, —Handbook of Telemedicine‖, IOS Press, Netherland, 2002.
2.	Khandpur R S, —Handbook of Biomedical Instrumentation‖, Tata McGraw Hill, New Delhi, 2003.
3.	Keith J Dreyer, Amit Mehta, James H Thrall, —Pacs: A Guide to the Digital Revolution‖, Springer, New York, 2002.
4.	Khandpur R S, —TELEMEDICINE – Technology and Applications‖, PHI Learning Pvt Ltd., New Delhi, 2017.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME10	**Biofluids and Dynamics**	3	0	0	3	50	50	100

Course Objective

The students should be made to

- Understand the basics of fluid mechanics.
- Analyze cellular, ocular, cardiovascular and respiratory fluid mechanics.
- Learn mathematical modelling of fluid biological systems.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Understand the basics of Fluid Mechanics.	K2
	CO2: Construe the intracellular fluid mechanics and ocular mechanics.	K1
	CO3: Describe the rheology of blood and mechanics of blood vessels.	K1
	CO4: Elucidate on cardiorespiratory mechanics and space medicine.	K3
	CO5: Develop mathematical models of biological systems with fluids	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2					2					3	2	
CO 2	3	3	2	2				2		2			3		2
CO 3	3	3	2	2									3	2	
CO 4	3	2	2	2				2		2			3		2
CO 5	3	2	2							2			3	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**BIOFLUID MECHANICS**	Periods	**9**
Intrinsic fluid properties - Density, Viscosity, Compressibility, Surface tension, Hydrostatics Fluid characteristics and viscosity – Displacement and velocity, Sheer stress and viscosity Bernoulli equation, Introduction to pipe flow – Reynolds number, Poiseuille's law, Flow Rate, Womersley number, Constitutive equations – Newtonian fluid, Non-Newtonian viscous fluid, Diameter, velocity and pressure of blood flow relationship, Resistance against flow, Viscoelasticity – Viscoelastic models, Response to Harmonic variation, Use of viscoelastic models, Bio-Viscoelastic fluids – Protoplasm, Mucus, Saliva, Synovial fluids.			
Unit – II	**CELLULAR AND OCCULAR MECHANICS**	Periods	**9**
Cellular Biomechanics – Eukaryotic cell architecture, Cytoskeleton, Cell-matrix interactions, Mechanical property measurement – Atomic Force microscopy, Optical Trapping, Magnetic bead microrheometry, Micropipette aspiration, Models of cellular biomechanical behavior, Computational model of a chondrocyte in its matrix, Mechanotransduction, Techniques for mechanical stimulation of the cells, Tissue cell mechanobiology – Endothelial, smooth muscle cells, Chondrocytes, Osteoblasts, Ocular Biomechanics – Occular anatomy, Biomechanics of Glaucoma, Ocular blood flow.			
Unit – III	**BLOOD RHEOLOGY AND BLOOD VESSEL MECHANICS**	Periods	**9**
Viscometry, Elements of Blood, Blood characteristics – Viscosity of blood, Einstein's equation, Biomechanics of red cell membrane, Apparent and relative viscosity, Blood viscosity variation,Casson"s equation, Rheology of Blood In Micro vessels – Fahraeus-Lindquist effect and its inversion, Anatomy and physiology of blood vessels, Arterial wall as membrane – Uniaxial loading, Biaxial loading, Torsion, Hemodynamics of Large arteries – Ventricular outflow and the aorta, Pressure-flow relations and Vascular Impedance, Wave propagation and reflection.			
Unit – IV	**CARDIO RESPIRATORY MECHANICS AND SPACE MEDICINE**	Periods	**9**
Cardiac cycle – Pressure volume diagrams, Changes in contractility, Ventricular performance, Congestive heart failure, Pulsality index, Physics of valvular diseases, Prosthetic heart valves and replacements, Respiratory System – Alveolar ventilation-lung volumes and capacities, Mechanics of breathing, Work of breathing – Lung compliance, Airway resistance, Gas exchange and transport, Oxygen dissociation curve, Lung surfactant, Pulmonary pathologies, Space Medicine – Hypoxia, Physiology of decompressive sickness, Human response to acceleration, Thermal Stress.			
Unit – V	**COMPUTATIONAL FLUID DYNAMICS**	Periods	**9**
Computational fluid dynamics – CFD Code, Problem solving with CFD, Conservation Laws of Fluid Motion and Boundary Conditions, Turbulence and its modelling, The Finite Volume Method for Diffusion Problems and Convection-Diffusion Problems, Solution Algorithms for Pressure-Velocity Coupling in steady flows, Solution of Discretized Equations, The Finite Volume Method for Unsteady flows, Implementation of Boundary Conditions Application – Multiphysics computational models for cardiac flow and virtual cardiography			
		Total Periods	**45**
Text Books			
1.	Krishnan B. Chandran, Ajit P. Yoganathan, Stanley E. Rittgers, —Biofluid Mechanics- The human circulation‖, CRC Taylor and Francis, 2007.		
2.	Y.C Fung, —Biomechanics- Mechanical properties of living tissues‖, 2nd Edition, Springer-Verlag, 1993.		
3.	Jeffery R. Davis et. Al., —Fundamentals of Aerospace Medicine‖, Wolter Kluwer Health, Lippincott Williams and Wilkins, 2008		

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References	
1.	Jung HeeSeo, Vijay Vedula, Theodore Abraham and Rajat Mittal, —Multiphysics computational models for cardiac flow and virtual cardiography‖, Int. J. Numer. Meth. Biomed. Engng. (2013) Published online in Wiley Online Library
2.	Lee Waite, Jerry Fine, —Applied Biofluid Mechanics‖, McGraw Hill, 2007
3.	John K-J Li, —Dynamics of Vascular System‖, World Scientific, 2004
4.	C. Ross Ethier, Craig A Simmons, —Introduction to Biomechanics- From Cells to Organisms‖, Cambridge Texts in Biomedical Engineering, 2007
5	H K Versteeg, W Malalasekera, —An Introduction to Computational Fluid Dynamics The Finite Volume Method‖, Longman Scientific and Technical, 1995

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME11	**Intellectual Property Rights**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Give an idea about IPR, registration and its enforcement.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Ability to manage Intellectual Property portfolio to enhance the value of the firm.	K2
	CO2: Explain the registrations of IPR's.	K2
	CO3: Explain about the Agreements and Legislations.	K2
	CO4: Explain the digital products and laws.	K2
	CO5: Ability to explain the enforcements of IPR's.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2					2					3	2	
CO 2	3	3	2	2				2		2			3		2
CO 3	3	3	2	2									3	2	
CO 4	3	2	2	2				2		2			3		2
CO 5	3	2	2							2			3	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION**	Periods	**9**
Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.			
Unit – II	**REGISTRATION OF IPRs**	Periods	**9**
Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad.			
Unit – III	**AGREEMENTS AND LEGISLATIONS**	Periods	**9**
International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.			
Unit – IV	**DIGITAL PRODUCTS AND LAW**	Periods	**9**
Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.			
Unit – V	**ENFORCEMENT OF IPRs**	Periods	**9**
Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.			
		Total Periods	**45**
Text Books			
1.	V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012.		
2	S. V. Satakar, —Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.		
References			
1.	Deborah E. Bouchoux, —Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets‖, Cengage Learning, Third Edition, 2012.		
2.	Prabuddha Ganguli,‖Intellectual Property Rights: Unleashing the Knowledge Economy‖, McGraw Hill Education, 2011.		
3.	Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code			**106**	Regulation		**2019**
Department	**BIOMEDICAL ENGINEERING**					Semester		**VI**
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME12	**Physiological Modeling**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Explain the application of Physiological models and vital organs. • Formulate the methods and techniques for analysis and synthesis of dynamic models. • Describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software. • Describe nonlinear models of physiological systems. • Compute the Simulation of physiological systems.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Explain the application of Physiological models.	K2
	CO2: Describe the methods and techniques for analysis and synthesis of Linear and dynamic system.	K3
	CO3: Develop differential equations to describe the compartmental physiological model.	K4
	CO4: Describe Nonlinear models of physiological systems.	K5
	CO5: Illustrate the Simulation of physiological systems.	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3										2		2	
CO 2		3	3	2	3								3	3	
CO 3		3	3	3	2										
CO 4	3	3													
CO 5					3									3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION TO PHYSIOLOGICAL MODELING**	Periods	**9**
Approaches to modeling: The technique of mathematical modeling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modeling.Introduction to physiology (homeostasis, cell biology) Modeling physicalsystems, linearmodels of physiological systems,the Laplace transform, Transfer functions and block diagram analysis Physiology.			
Unit – II	**MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM**	Periods	**9**
Dynamic systems and their control, modeling and block diagrams, the pupil control systems(Human Eye), general structure of control systems, the dynamic response characteristics of the pupil control system, open &close loop systems instability, automatic aperture control.			
Unit – III	**NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS**	Periods	**9**
Nonparametric Modeling-Volterra Models.Wiener Models. Efficient Volterra Kernel Estimation.Parametric Modeling- Basic Parametric Model Forms and Estimation Procedures- Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.			
Unit – IV	**COMPARTMENTENTAL PHYSIOLOGICAL MODEL**	Periods	**9**
Modeling the body as compartments, behaviour in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modeling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation.Mathematical modeling of the system: Thermo regulation, Thermoregulation of cold bloodedness& warm bloodedness, the anatomy of thermo regulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.			
Unit – V	**SIMULATION OF PHYSIOLOGICALSYSTEMS**	Periods	**9**
Simulation of physiologicalsystemsusing Open CV / MATLAB software. Biological receptors: -Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity. Neuromuscular model, Renal System, Drug Delivery Model.			
		Total Periods	**45**

Text Books	
1.	Michel C Khoo, —Physiological Control Systems -Analysis, simulation and estimation‖, Prentice Hall of India, 2001.
2.	Marmarelis, —Nonlinear Dynamic Modeling of Physiological Systems‖, Wiley-IEEE Press,2004.
References	
1.	Benjamin C Kuo, —Automatic control systems‖, Tenth Edition, McGraw-Hill Education, 2017.
2.	DavidTWestwick, Robert E. Kearney, Identification of Nonlinear PhysiologicalSystems, Wiley-IEEE Press, 2003.
3.	V.Z. Marmarelis, —Advanced methods of physiological modeling‖ , *Springer*, 1989.
4.	L.Stark,‖ Neurological Control System, Plenum Press‖,1968.
5.	John H Milsum , —Biological control systems‖, McGraw Hill 1966.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME13	**Robotics in Medicine**	3	0	0	3	50	50	100

Course Objective

The students should be made to

- Understand the basics of Robotics, Kinematics.
- Understand the basics of Inverse Kinematics.
- Explore various kinematic motion planning solutions for various Robotic configurations.
- Explore various applications of Robots in Medicine.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Understand the basics of robotic systems.	K4
	CO2: Design basic Robotics system and formulate Kinematics.	K4
	CO3: Construct Inverse Kinematic motion planning solutions for various Robotic configurations.	K2
	CO4: Explain the planning of robots.	K3
	CO5: Design Robotic systems for Medical application.	K4
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	2	2	2					2				3	3	2
CO 2	2	3	2	2		3							3	3	3
CO 3	3	2	2	2		2			2				3	3	
CO 4	2	2	2	2		2							2	2	2
CO 5	2	2	2			3	3		2				2	3	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**INTRODUCTION**	Periods	**9**
Introduction Automation and Robots, Classification, Application, Specification, Notations, Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation – Five-axis robot, Four-axis robot, Six-axis robot			
Unit – II	**KINEMATICS**	Periods	**9**
Inverse Kinematics – General properties of solutions tool configuration, Five axis robots, Three-Four axis, Six axis Robot, Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.			
Unit – III	**ROBOT VISION**	Periods	**9**
Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation – Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration.			
Unit – IV	**PLANNING**	Periods	**9**
Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.			
Unit – V	**APPLICATIONS**	Periods	**9**
Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics, Neurosurgery			
		Total Periods	**45**

Text Books

1.	Robert Schilling, —Fundamentals of Robotics-Analysis and control‖, Prentice Hall, 2003.
2.	J.J.Craig, —Introduction to Robotics‖, Pearson Education, 2005.

References

1.	Staugaard, Andrew C,—Robotics and Artificial Intelligence: An Introduction to Applied Machine Learning‖, Prentice Hall Of India, 1987.
2.	Grover, Wiess, Nagel, Oderey, —Industrial Robotics: Technology, Programming and Applications‖, McGraw Hill, 1986.
3.	Wolfram Stadler, —Analytical Robotics and Mechatronics‖, McGraw Hill, 1995.
4.	Saeed B. Niku, —Introduction to Robotics: Analysis, Systems, Applications‖, Prentice Hall, 2001.
5.	K. S. Fu, R. C. Gonzales and C. S. G. Lee, —Robotics‖, McGraw Hill, 2008.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME14	**Internet of Things**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Understand Smart Objects and iot Architectures. • Learn about various IOT-related protocols. • Build simple iot Systems using Arduino and Raspberry Pi. • Understand data analytics and cloud in the context of iot. • Develop IoT infrastructure for popular applications.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Explain the concept of IoT.	K2
	CO2: Analyze various protocols for IoT.	K2
	CO3: Design a PoC of an IoT system using Rasperry Pi/Arduino.	K3
	CO4: Apply data analytics and use cloud offerings related to IoT.	K4
	CO5: Analyze applications of IoT in real time scenario.	K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2					2					3	2	
CO 2	3	3	2	2				2		2			3		2
CO 3	3	3	2	2									3	2	
CO 4	3	2	2	2				2		2			3		2
CO 5	3	2	2							2			3	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**FUNDAMENTALS OF IoT**	Periods	**9**
Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack — Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects.			
Unit – II	**IoT PROTOCOLS**	Periods	**9**
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.			
Unit – III	**DESIGN AND DEVELOPMENT**	Periods	**9**
Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.			
Unit – IV	**DATA ANALYTICS AND SUPPORTING SERVICES**	Periods	**9**
Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG.			
Unit – V	**CASE STUDIES/INDUSTRIAL APPLICATIONS**	Periods	**9**
Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.			
		Total Periods	**45**

Text Books	
1.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, —IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
References	
1.	Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach‖, Universities Press, 2015.
2.	Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols‖, Wiley, 2012 (for Unit 2).
3.	Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
4.	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things‖, Springer, 2011.
5.	Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205						
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BME15	**Soft Computing Techniques**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Understand the different soft computing techniques. • Understand neural network architectures and learning algorithms, for different applications. • Explore the use of Fuzzy and Genetic Algorithm. • Understand different Optimization techniques in soft computing. • To introduce Hybrid and Other advanced model in soft computing.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Describe various neural, fuzzy and Genetic algorithms.	K2,K4
	CO2: Implement Neural, Genetic and Fuzzy algorithms for various classification applications.	K3,K4
	CO3: To explain about the genetic algorirthm.	K3,K5
	CO4: Gain knowledge in optimization using soft computing.	K2,K5
	CO5: Gain knowledge in hybrid and advanced model in soft computing.	K1,K3
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	2		2	2	2			1				2	3	1	3
CO 2	2		1	2	1			3			2	2	3	1	3
CO 3	1		1						2		1	3	2	1	3
CO 4	2		2		2			2				2	3	1	3
CO 5	2		1						3			3	1	1	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**FROM BIOLOGY TO ARTIFICIAL NEURAL NETWORKS –INTRODUCTION**	Periods	**9**
Biological Neural Networks, Components of Artificial Neural Networks – Connections, Propagation function and Network Inputs, Common Activation Functions, Threshold, Network Topologies, Learning - Supervised, Unsupervised, Reinforcement. Backpropagation, Radial Basis Function, Self-Organizing Maps, Counter Propagation Networks, Adaptive Resonant Theory (ART).			
Unit – II	**FUZZY SET THEORY**	Periods	**9**
Introduction to Fuzzy – Fuzzy Sets – Basic Definition and Terminology – Set-theoretic Operations – Member Function Formulation and Parameterization – Fuzzy Rules and Fuzzy Reasoning – Extension Principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modelling.			
Unit – III	**GENETIC ALGORITHM**	Periods	**9**
Genetic Algorithms: Introduction to Genetic Algorithms (GA), Representation, Operators in GA, Fitness function, population, building block hypothesis and schema theorem.; Genetic algorithms operators methods of selection, crossover and mutation, simple GA (SGA), other types of GA, generation gap, steady state GA.			
Unit – IV	**OPTIMIZATION USING SOFT COMPUTING**	Periods	**9**
Single variable optimization - Region Elimination Methods, Fibonacci Search Method, Multivariable Optimization - Cauchy's Steepest Descent Method, Newton's method, Swarm Intelligence-Particle Swarm Optimization, ANT Intelligence – ANT Colony Optimization, Artificial Bee Colony Algorithm, Jumping Frog Optimization.			
Unit – V	**HYBRID AND ADVANCED MODEL IN SOFT COMPUTING**	Periods	**9**
Genetic Algorithm based Back propagation Network, Fuzzy Logic Controlled Genetic Algorithms, Neuro-fuzzy hybrid systems, Support Vector Machine, Extreme Learning Machine (ELM), Extended ELM, Random Forest Algorithm.			
		Total Periods	**45**
Text Books			
1.	J.S.R.Jang, C.T.Sun and E.Mizutani, —Neuro-Fuzzy and Soft Computing‖, PHI, 2004, Pearson Education 2004.		
2.	Davis E.Goldberg, —Genetic Algorithms: Search, Optimization and MachineLearning‖, Addison Wesley, N.Y., 1989		
References			
1.	LaureneFausett, —Fundamentals of neural networks- Architectures, algorithms and applications‖, Prentice Hall, 1994.		
2.	Simon O. Haykins,‖Neural Networks: A Comprehensive Foundation‖, 2nd Edition, Pearson 1994		
3.	Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.		

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code		**106**	Regulation		**2019**	
Department	**BIOMEDICAL ENGINEERING**				Semester		**VI**	
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BME16	**Acoustics and Optical Imaging**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Provide knowledge about various microscopic imaging systems to analyze biological system.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Analyze the various principles of physics used in acoustic imaging.	K1
	CO2: Explain about the acoustic imaging modalities.	K2
	CO3: Differentiate the various image capturing techniques.	K3
	CO4: Illustrate the special techniques used in optical microscopy.	K4,K2
	CO5: Explain about the working principles of fluorescence imaging.	K1
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	2											2	1		
CO 2	2	3	3	3	3							1	3	3	3
CO 3	2		3	3	3							1	3	2	3
CO 4	3	3	3	3	3							1	3	3	3
CO 5	1		3	3								1	3	2	3

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**PHYSICS OF ACOUSTICS**	Periods	**9**
The sine wave, sound in media-particle motion, propagation of sound. Speed of sound - wavelength and frequency, complex waves harmonics. Phase, partials, octaves, spectrum, electrical, mechanical and acoustic analogs. Wave phenomenon : wavefronts, Interference, reflection, scattering, diffraction, refraction, doppler effect, convection. Sound levels and decibel: ratios versus differences, logarithms, decibels, reference levels. Comparison of Logarithmic and exponential forms, acoustic power. Measuring sound pressure level, sine wave measurement.			
Unit – II	**ACOUSTIC IMAGING**	Periods	**9**
Fundamentals of photo acoustic tomography : photo acoustic effect, image reconstruction methods, instrumentation. Transducer array-based photo acoustic tomography: array-based PAT system and 2D imaging, 3D imaging,4D imaging. Photo acoustic microscopy and computed microscopy: optical-resolution, acoustic-resolution, C-scan photo acoustic microscopy, photo acoustic computed microscopy. Photo acoustic microscopy based on acoustic lens with variable focal length, confocal photo acoustic microscopy using a single multifunctional Lens.			
Unit – III	**IMAGE CAPTURE**	Periods	**9**
Optical contrasting techniques: dark field, phase contrast, polarization, differential interference contrast, Hoffman modulation contrast. Filter sets: excitation filter, dichroic mirror, and barrier filter. Optical layout for image capture, color recording, additive color model, subtractive color model. CCD cameras, frame-transfer array, interline-transfer array. Back illumination, binning, capturing color, filter wheels, filter mosaics. Three CCD elements with dichronic beam splitters, boosting the signal.			
Unit – IV	**MICROSCOPY AND THREE DIMENSIONAL IMAGING**	Periods	**9**
Nonlinear microscopy: multiphoton microscopy, principles of two -photon fluorescence, lasers for nonlinear microscop,advantages of two-photon excitation. Construction of a multiphoton microscope, fluorochromes for multiphoton microscopy, second harmonic microscopy. High-speed confocal microscopy: tandem scanning (spinning disk) microscopes, petràn system, one-sided tandem scanning microscopes (OTSMS). Microlensarray: the Yokogawa system, slit-scanning microscopes, multipoint-array scanners, structured illumination. Surfaces: two-and-a-half dimensions, perception of the 3D world, motion parallax, convergence and focus of our eye. Perspective, concealment of one object by another, light and shade, limitations of confocal microscopy. Stereoscopy : three-dimensional reconstruction, techniques that require identification of objects, techniques that create views directly from intensity data. Simple projections, weighted projection (alpha blending).			
Unit – V	**FLUORESCENCE AND ITS ADVANCED TECHNIQUES**	Periods	**9**
Fluorescent staining: immuno labeling, types of antibody, raising antibodies, labeling, fluorescent stains for cell components and compartments. Quantitative fluorescence: fluorescence intensity measurements, linearity calibration, measurement, co-localization, ratio imaging. Cell loading, membrane potential, fast-response dyes, slowresponse dyes, fluorescence recovery after photo bleaching. Fluorescence lifetime Microscopy(FLIM), Practical Lifetime Microscopy, frequency domain, time domain. Fluorescence Resonant Energy Transfer (FRET), identifying and quantifying fret, increase in brightness of acceptor emission, quenching of emission from the donor. Lifetime of donor emission, protection from bleaching of donor, Fluorescence Correlation Spectroscopy (FCS), raster image correlation spectroscopy.			
		Total Periods	**45**

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Text Books	
1.	F. Alton Everest, Ken Pohlmann, "Master Handbook of Acoustics", McGraw-Hill, 6th edition,2014.
2.	Huabei Jiang, "Photoacoustic Tomography" CRC press, Taylor & Francis Group, 1st edition, 2015.
3.	Guy cox, "Optical Imaging Techniques in Cell Biology", CRC press, Taylor & Francis Group, 2nd edition, 2012.
4.	Jose Luís del Cura, Pedro Seguí, Carlos Nicolau, "Learning Ultrasound Imaging", Springer, 1st edition 2012.
5.	Peter R. Hoskins, Kevin Martin, Abigail Thrush, "Diagnostic Ultrasound: Physics and Equipment", Cambridge university press, 2nd edition, 2010.
6.	Gerhard K. Ackermann, Jürgen Eichler, "Holography: A Practical Approach", WILEY-VCH Verlag GmbH & Co, 1st edition, 2008.
7.	Tuan Vo Dirh, "Biomedical photonics – Handbook", CRC Press, 2nd edition, 2003.
References	
1.	Frank J. Fahy, "Foundations of Engineering Acoustics", academic press, 1stedition, 2005.

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
(Autonomous Institution, Affiliated to Anna University ,Chennai)
Elayampalayam, Tiruchengode – 637 205

Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BMOE4	**Medical Robotics**	3	0	0	3	50	50	100

Course Objective

The students should be made to
- Understand the basics of Robotics, Kinematics.
- Understand the basics of Inverse Kinematics.
- Explore various kinematic motion planning solutions for various Robotic configurations.
- Explore various applications of Robots in Medicine.

Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Categorize the robots and actuators to move and control the system.	K1,K3
	CO2: Identify the sensors like acceleration, light, proximity, touch and sniff for a robot to estimate the environmental condition.	K2,K4
	CO3: Illustrate the mechanism of robots using forward and inverse kinematics methods.	K3,K5
	CO4: Examine the motion of robot and prepare the trajectory of a robot using jacobian and lagrangian mechanics.	K2,K5
	CO5: Explain the advancement of robotics in medicine.	K3,K5

Pre-requisites -

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3									1	3	3	
CO 2	3	3	3									1	3	3	
CO 3	3	3	3									1	3	3	
CO 4	3	2											3	2	
CO 5	3				2								3	2	

Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus			
Unit – I	**ROBOTICS AND THEIR CLASSIFICATION**	Periods	**9**
History of robots - Classification - Robot coordinates- Reference frames- Programming modes Characteristics of robot- Actuators - Characteristics of actuating systems, hydraulic actuators, pneumatic devices, electricmotors.			
Unit – II	**SENSORS**	Periods	**9**
Sensors, characteristics of sensor, position sensors, velocity sensors, acceleration sensors, force and pressure sensors, torque sensors, light and infrared sensors, touch and tactile sensors, proximity sensors, range finders, sniff sensors, vision systems, voice recognition devices, voice synthesizers.			
Unit – III	**ROBOT KINEMATICS**	Periods	**9**
Robots as mechanisms, matrix representation, homogeneous transformation matrices, representation of transformations, inverse of transformation matrices, Forward and inverse kinematics of robots, DH representation of forward kinematic equations of robots, inverse kinematic solution of robot. Inverse kinematics programming of robots, degeneracy and dexterity.			
Unit – IV	**ROBOT DYNAMICS**	Periods	**9**
Differential motions of a frame, differential changes between frames, calculation of the jacobian – Inverse jacobian, lagrangian, lagrangian mechanics of spring cart system, and degrees of freedom robot arm trajectory planning: introduction - Path vs trajectory - Joint-Space vs Cartesian-Space Descriptions- Basics of trajectory planning -Joint-Space trajectory planning			
Unit – V	**CASE STUDIES**	Periods	**9**
Biomedical Image Analysis on Wireless Capsule Endoscopy Images and Videos, Cooperative Control Design in Drug Delivery, Cancer Targeted Therapy, Catheter Surgery System.			
		Total Periods	**45**

Text Books	
1.	Saced B. Niku"Introduction to Robotics Analysis, Systems, Applications", Prentice Hall of India/Pearson Education,2002.
2.	Yi Guo "Selected Topics in Micro/Nano-Robotics for Biomedical Applications", 2013.
References	
1.	Craig, "Introduction to Robotics Mechanics and Control", Pearson Education, 2nd Edition, 2004.edition,2013.
2.	Mittal.R.K and Nagrath.I.J "Robotics and Control", McGraw Hill, 2003.
3.	Fu.K.S. & Co., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill International Editions, Industrial Engineering Series, 1991.
4.	Klafter.R.D, T.A. Chimielewski and M.Negin "Robotic Engineering - An integrated Approach", Prentice Hall of India, 2002.
E-Resources	
1.	https://onlinecourses.nptel.ac.in/noc18 me61/preview

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	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution, Affiliated to Anna University ,Chennai) Elayampalayam, Tiruchengode – 637 205							
Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**			
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**			
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BMOE5	**Healthcare Management Systems**	3	0	0	3	50	50	100

Course Objective	The students should be made to • Understand the fundamentals of hospital administration and management. • Know the market related research process • Explore various information management systems and relative supportive services. • Learn the quality and safety aspects in hospital.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge level
	CO1: Describe the basic planning and organization of hospitals using guiding principles.	K1,K3
	CO2: Explain the roles and responsibilities in Hospital Administration and Human Resource management with organizational hierarchy.	K2,K4
	CO3: Identify and explain the role of medical and support services used for proper functioning of the hospitals.	K3,K5
	CO4: Interpret various Engineering and other essential services of a hospital.	K2,K5
	CO5: Identify and explain the key elements of security and safety management in Hospitals.	K3,K5
Pre-requisites	-	

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3		2								3	2	
CO 2	3				2								3		
CO 3	3		2										3		
CO 4	3	2											3	2	
CO 5	3				2								3	2	

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment. 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**HOSPITAL PLANING**	Periods	**9**
Roles of hospital in healthcare-Planning the Hospitals – Guiding principles in planning hospital facilities and services –Preliminary survey – Financial planning – Equipment Planning – Purchase of capital equipment.			
Unit – II	**ORGANIZATION AND HOSPITAL OPERATION MANAGEMENT**	Periods	**9**
Organizational structure - Management Structure – Organizational Charts– Professional management – Recruitment and selection – Orientation, training and selection.			
Unit – III	**MEDICAL AND SUPPORTIVE SERVICES**	Periods	**9**
Outpatient services – Clinical Laboratory services – Surgical Department – Hospital Information System - Medical Records - Pharmacy – Central Sterile Supply Department (CSSD) - Materials Management.			
Unit – IV	**DESIGNING OF HOSPITAL SERVICES**	Periods	**9**
Engineering department - Maintenance management- Clinical engineering – Electrical system- Air conditioning system- Water supply and sanitary system – Centralized medical gas system.			
Unit – V	**HOSPITAL SAFETY AND SECURITY**	Periods	**9**
Safety in hospital – Security and loss prevention programme – Fire safety- Alarm system- Disaster management.			
		Total Periods	**45**

Text Books

1.	G.D.Kunders, "Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007.

References

1.	R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006.
2.	B.M. Sakharkar, "Principles of hospital administration and planning", Jaypee Brothers Medical Publishers Pvt Limited, 2nd edition, 2009.
3.	Norman Metzger, "Handbook of Health Care Human Resources Management", 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.

E-Resources

1.	https://www.youtube.com/watch?v=ZZS8-ySBNFM, "Organisation and Management of Hospital", Prof. S.B.Aroara, Professor, School of Health Sciences, Indira Gandhi National Open University (IGNOU), MaidanGarhi, New Delhi.
2.	http://www.nptelvideos.in/2012/11/human-resourses-mangements-i.html, "Lecture Series on Human Resource Management-I", Prof.KalyanChakravarti, Vinod Gupta School of Management, IIT Kharagpur.

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VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
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Programme	**B.E**	Programme Code	**106**	Regulation	**2019**
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19BMOE6	**Biometric Systems And Their Applications**	3	0	0	3	50	50	100

Course Objective

The students should be made to
- Understand the technologies of fingerprint, iris, face and speech recognition
- Understand the general principles of design of biometric systems and the underlying trade-offs.
- Recognize personal privacy and security implications of biometrics based identification technology.
- Identify issues in the realistic evaluation of biometrics based systems.

Course Outcome

At the end of the course, the student should be able to,	Knowledge level
CO1: Demonstrate knowledge on biometric authentication system using biometric applications.	K1,K3
CO2: Explain the fingerprint technology using fingerprint enhancement, feature extraction, classification and matching technique used for criminal application.	K2,K4
CO3: Design face recognition system using neural network, video sequences used for various biometric applications.	K3,K5
CO4: Describe about iris recognition and hand geometry using segmentation and feature extraction technique used for commercial application.	K2,K5
CO5: Identify issues in multimodal biometrics using face and ear used for biometric application.	K3,K5

Pre-requisites -

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**

COs	Programme Outcomes (POs)												**CO/PSO Mapping** PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	3		2								3	2	
CO 2	3				2								3		
CO 3	3		2										3		
CO 4	3	2											3	2	
CO 5	3				2								3	2	

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Course Assessment Methods

Direct
1. Continuous Assessment Test I, II & III 2. Assignment. 3. End-Semester examinations
Indirect
1. Course - end survey

Content of the syllabus

Unit – I	**BIOMETRICS SYSTEM**	Periods	**9**
History of Biometrics – Types of Biometric Traits – General Architecture of Biometric Systems – Basic working of Biometric matching – Biometric system error and performance measure.			
Unit – II	**FINGERPRINT BIOMETRICS**	Periods	**9**
Finger print using vein pattern of palm – Fingerprint Biometrics – Fingerprint recognition system – minutiae extraction – advantage and disadvantages of fingerprint biometrics.			
Unit – III	**FACE RECOGNITION**	Periods	**9**
Background of face recognition – design of face recognition system - neural network for face recognition – face detection in video sequences – face recognition methods.			
Unit – IV	**IRIS RECOGNITION & HAND GEOMETRY**	Periods	**9**
Design of iris recognition system – iris segmentation method – application of iris biometrics – basics of hand geometry – image capturing, hand segmentation, feature extraction.			
Unit – V	**MULTIMODAL BIOMETRICS & BIOMETRIC APPLICATIONS**	**Periods**	**9**
Basic architecture of multi model biometrics – multi model biometrics using face and ear – multi model biometrics application – case study of biometric application.			
		Total Periods	**45**

Text Books

1.	G.R.Sinha, SandeepB.Patel, "Biometrics:Concepts and Applications", Wiley Publicatios, 1st edition,2013.

References

1.	James Wayman, Anil Jain, DavideMaltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005.
2.	Arun A Ross, KarthikNandakumarand Anil K.Jain, "Handbook of Multibiometics", Springer,2006.

E-Resources

1.	http://NPTEL/biometrics-IIT-kanpur, "Biometric Systems", Prof. PhalguniGupt , IIT, khanpur.

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Programme	**B.E.**	Programme Code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**		
Course Code	Course Name	Periods Per Week			Credit	Maximum Marks	
		L	T	P	C	CA	ESE	Total
U19BM614	**Medical Image Processing Laboratory**	0	0	2	2	50	50	100
Course Objective	The student should be made to, • Practice the basic image processing techniques. • Compute magnitude and phasor representation of images. • Understand the concepts of image restoration and segmentation. • Explore the applications of image processing techniques.						
Course Outcome	At the end of the course, the student should be able to,					Knowledge Level	
	CO1: Perform enhancing operations on the image using spatial filters and frequency domain filters.					K2	
	CO2: Use transforms and analyse the characteristics of the image.					K2	
	CO3: Perform segmentation operations in the images.					K2	
	CO4: Estimate theefficiency of the compression technique on the images.					K2	
	CO5: Apply image processing technique to solve real health care problems.					K2	
Pre-requisites	-						

CO / PO Mapping (3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 - Weak**													**CO/PSO Mapping**		
COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	3	3	2	3	3	2	1					3	2	3	3
CO 2	3	3	2	3	3	2	1					3	2	3	3
CO 3	3	3	2	2	3	3	1					3	3	2	3
CO 4	3	3	2	3	3	3	1					3	3	2	3
CO 5	3	3	3	3	3	3	2					3	3	2	3

Course Assessment Methods

Direct
1. Prelab and post lab test 2. End-Semester examinations
Indirect
1. Course - end survey

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Content of the syllabus

SUGGESTED LIST OF EXPERIMENTS:

Simulation using MATLAB

1. Image sampling and quantization
2. Analysis of spatial and intensity resolution of images.
3. Intensity transformation of images.
4. DFT analysis of images
5. Transforms (Walsh, Hadamard, DCT, Haar)
6. Histogram Processing and Basic Thresholding functions
7. Image Enhancement-Spatial filtering
8. Image Enhancement- Filtering in frequency domain
9. Image segmentation – Edge detection, line detection and point detection.
10. Basic Morphological operations. 106
11. Region based Segmentation
12. Segmentation using watershed transformation
13. Analysis of images with different color models.
14. Study of DICOM standards
15. Image compression techniques
16. Image restoration
17. A mini project based on medical image processing

Total Periods	**45**

Suggested Lab Manuals:	
1.	Laboratory Manual. IMAGE PROCESSING. For. Final Year Students. Manual made by. Prof.A.G.PATIL.

E-Resources	
1.	https://miplab.epfl.ch/
2.	https://www.srmist.edu.in/content/medical-image-processing-lab
3.	https://uwaterloo.ca/vision-image-processing-lab/research-topics/biomedical-imaging

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Programme	**B.E.**	Programme code	**106**	Regulation	**2019**		
Department	**BIOMEDICAL ENGINEERING**			Semester	**VI**		

Course code	Course Name	Periods /Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
U19EC522	**Microprocessor and Microcontroller Laboratory**	0	0	2	1	50	50	100

Course Objective	The student should be made to, • Introduce ALP concepts, features and Coding methods. • Write ALP for arithmetic and logical operations in 8086 and 8051. • Differentiate the Serial and Parallel Interface. • Interface different I/Os with Microprocessors. • Determine the operation of Microprocessors, Arduino and PIC.	
Course Outcome	At the end of the course, the student should be able to,	Knowledge Level
	CO1: Illustrate the ALP concepts and features.	K2
	CO2: Develop various arithmetic and logical operations in 8086 and 8051.	K3
	CO3: Analyze the Serial and Parallel Interface.	K4
	CO4: Distinguish the interface between different I/Os with Microprocessors, Arduino and PIC.	K3
	CO5: Evaluate the data transfer information through serial & parallel ports with Microprocessors, Arduino and PIC.	K6
Pre-requisites	-	

CO / PO Mapping
(3/2/1 indicates strength of correlation) **3-Strong, 2 – Medium, 1 – Weak**

CO/PSO Mapping

COs	Programme Outcomes (POs)												PSOs		
	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO 1	2	1	1												
CO 2	2	1	1												
CO 3	2	1	1												
CO 4	2	1	1												
CO 5	2	1	1					3	3				2	2	

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Course Assessment Methods

Direct
1. Pre lab and Post lab Test. 2. Assignment 3. End-Semester examinations
Indirect
1. Course - end survey.

Content of the syllabus

8086 Programs using kits and MASM

1. Programs for 16 bit Arithmetic operations.
2. Programs for Sorting and Searching using MASM
3. Interfacing ADC and DAC.
4. Parallel Communication between two MP Kits using Mode 1 and Mode 2 of 8255.
5. Interfacing and Programming 8279, 8259, and 8253.
6. Serial Communication between two MP Kits using 8251.
7. Interfacing and Programming of Stepper Motor and DC Motor Speed control.

8051 Experiments using kits

1. Programming using Arithmetic, Logical and Bit Manipulation instructions of 8051 microcontroller.
2. Communication between 8051 Microcontroller kit and PC.

Arduino

1. Interfacing switch and LED with Arduino.

PIC

2. Interrupt programming using PIC.
3. USART programming using PIC.

Miniproject

Total Periods	**45**

Text Books

1.	Yu-Cheng Liu, Glenn A. Gibson, "Microcomputer Systems: The 8086 / 8088 Family – Architecture, Programming and Design", 2nd Edition, Prentice Hall of India, 2014.
2.	Muhammed Ali Mazidi, Rolind D Mckinlay, Danny Causey "PIC Microcontroller and Embedded Systems", Pearson Edition 2008.
3.	Michael-Margolis,Arduino-Cookbook., Revised edition, O'Reilly,1st edition, 2011.
4.	D.Dale.Wheat, Arduino.Internals, TIA publication, 5th edition, 2011.

E-Resources

1.	https://pdfcoffee.com/1pdfnetmicrocomputer-systems-the-8086-8088-family-architecture-pdf-pdf-free.html
2.	http://www.staroceans.org/kernel-and-driver/PIC%20Microcontroller%20and%20Embedded%20Systems%20Using%20ASM%20%26%20C%20for%20PIC18.pdf
3.	https://www.worldcat.org/title/pic-microcontroller-and-embedded-systems-using-assembly-and-c-for-pic18/oclc/77476437

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