Contents

Preface

Welcome to the Department of Electronic and Telecommunication Engineering (ENTC). This handbook provides a general overview of the undergraduate program you are about to embark on, which include the areas of expertise, faculty profile, curriculum, laboratories and facilities available and life at the department. This will guide you in planning your academic journey in terms of course selection, project undertaking and other activities to fulfill the graduation requirements. You will also find information about scholarships, student clubs and career opportunities. We invite you to utilize the resources available at the department and wish you a pleasant and fruitful stay.

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Introduction

The Department of Electronic and Telecommunication Engineering at the University of Moratuwa, continues to thrive on the heritage of excellence, backed up by exceptional teaching, research and laboratory facilities. With a legacy of 50 years, ENTC steadlily produces quintessential engineering professionals to the nation.

Department Mission

"Impart and improve the theoretical knowledge and practical skills of students in Electronic and Telecommunication Engineering, keeping pace with the rapid developments while significantly contributing to the wealth of knowledge by way of high quality research."

We produce multi-faceted electronic, telecommunication and biomedical engineering graduates who have proven to be adept in national and global arena. We conduct two four-year Bachelor of the Science of Engineering Honors degree programs, two taught postgraduate Master of Science programs and several postgraduate research programs leading to M.Sc., M.Phil. and Ph.D. degrees. Currently, there are approximately 400 undergraduate students enrolled in our programs.

The department is housed in the iconic four-storied building in the east-side of the university and has nine laboratories with facilities for students to carry out laboratory assignments and project work. In addition, the department has forged strong partnerships with the industry in order to promote collaborative work. As a result, three industry-sponsored laboratories have been established as joint ventures between the University of Moratuwa and Dialog Axiata, Zone24x7 and Premium International. These laboratories make significant contributions to the growth of the electronic and telecommunication industries.

The department recently established the Advanced Electronic Development Centre to catalyze the development of niche areas in electronics including semiconductor integrated circuit (IC), intellectual property (IP) and printed circuit board (PCB) design and development.

In addition to academic and research work, the department provides consultancy services to many government institutions in the fields of education, science and technology, and national security.

Study Programmes Offered

Undergraduate Programmes

- Bachelor of the Science of Engineering Honours Degree in Electronic and Telecommunication Engineering
- Bachelor of the Science of Engineering Honours Degree in Biomedical Engineering

Postgraduate Programmes (Taught)

- Master of Science/Postgraduate Diploma in Telecommunications
- Master of Science/Postgraduate Diploma in Electronics and Automation

Postgraduate Programmes (Research)

- Master of Science
- Master of Philosophy
- Doctor of Philosophy

Short Courses

- Training Course on Microcontroller Based System Design
- Training Course on Industrial Automation and Programmable Logic Controllers (PLCs)

Welcome

Welcome to the Department of Electronic and Telecommunication Engineering. Since 1969 talented students like you have walked the path that you are about to embark on. Conscientious academic work that lays a thorough foundation of principles, creativity, real-world problem solving, technology leadership, extra-curricular activities, and professionalism will mould you into a highly proficient engineer with up-to-date knowledge.

In doing so, you will become either a professional engineer, an achiever who would lead organizations, or a technology leader who would champion novel technologies. All these are for the benefit of the citizens of our country and the body of knowledge that drives the world. In view of this, I wish you strength and determination to fully engage with the program that we offer with an outlook that reaches the real world of engineering.

Two bachelor of the science of engineering programs are offered at the department: Electronic and Telecommunication Engineering, and Biomedical Engineering. In each program, you will start with the fundamental theoretical concepts in the early semesters, leading to system-level knowledge and skills in the final semesters. I encourage you to see each course module as a building block of the structure that would make you a competent engineering professional. When following such a course module, you must inquire on your own how it would fit in this large structure. Try to make connections between the course module at hand and what you have already learnt. Ask questions as to how this would make you one of the engineers--- a professional, an achiever, or a technology leader--- when you join the world of work or research. The course modules and the program itself will become meaningful and enjoyable if you adopt the mindset that I just described.

There is a faculty of highly talented and resourceful academics in the department to make your stay meaningful and worthwhile. The industrious academic staff engage in efficacious teaching, carry out research to contribute to the body of knowledge, and administrative work, all of which will benefit you both directly and indirectly. Your level of engagement in the knowledge dissemination process---preparation at home, active participation in lectures---will encourage them to be more enthusiastic in teaching you. Your keen interest in discussions outside the classroom and contribution to research projects that they manage will pave the way for you to start research-oriented work. Fully benefitting from the teaching, and engaging in research work with academic staff members will mould you into an engineer who would be an asset to the society.

Toward this goal of making your mark in the society, you must identify your key performance indicators. I can suggest you some: a good grade-point average supplemented by extra-curricular work and sports, research publications in good conferences and journals, making relationships with academic staff members and industry, and having a spectacular curriculum vitae that lists a number of industry- and research-relevant skills and significant projects. The department, its facilities, academic and non-academic staff members are there to assist you in achieving these performance targets.

Along with the staff of the department, I wish you all the best in reaching these targets and becoming the engineer--- the professional, the achiever, or the technology leader--- that you are determined to become.

Dr. Nuwan Dayananda

Head of Department

Career Opportunities

The competitive environment prevailing in the electronics, telecommunication and IT industry has resulted in the rapid deployment of advanced technologies in Sri Lanka. Consequently, challenging and lucrative career opportunities have become available to Electronic, Telecommunication and Biomedical engineers.

Our program will equip the students with the knowledge and skills necessary to excel in all these areas. The blend of diverse and multidisciplinary areas taught in our program makes it one of the fastest changing and challenging specializations of engineering.

Over the last decade, large networks of cellular, satellite and data communication have been introduced to the country, providing state-of-the-art services. Organizations providing traditional communication services are expanding, incorporating modern technologies into their systems. Telecommunication engineers have the opportunity of building their future careers within these organizations. Our graduates have found employment in every aspect of the telecommunication industry, from network planning to business and management related areas. With the recent trends in the telecommunication industry to look beyond voice to data services, new markets based on value added services are taking center stage. Our graduates will find new markets in these areas with their innovative thinking and excellent programming skills.

The manufacturing and process industries are becoming increasingly sophisticated with the adoption of advanced automation methods.They provide challenging opportunities for more electronics-oriented careers. In the global context more telecommunications, consumer, computer, industrial and automotive products are evolving toward embedded, system-on-chip design and development models related to these technologies. Our graduates will, in the future, play a major role in the global embedded electronics design chain as well.

The software industry in Sri Lanka is rapidly expanding. An Increasing number of our graduates have found a firm footing in this market. With the advent of technologies such as cloud computing and smart phones many of the companies are moving towards telecommunication related software development. These markets are held by our graduates.

The department has diversified its electronics and automation fields to include internet of things, hardware acceleration, robotics and computer vision.

One of the key sucess factors of the department is its ability to be proactive about the needs of the industry. We have always maintained a close and cordial relationship with the industry which has benefited our undergraduates and graduates immensely. The industry has been our partner in creating an employable graduate. The constructive comments made by these eminent people have shaped the manner in which the teaching and learning process has been carried out within the department.

This close corporation has enabled our undergrduates to be aware of the expectations of the industry well before they graduate. This collective effort has enabled our graduates to identify, prepare and embark on a career of their choice even before graduation.

Contact Information

Where is the Department Located?

The Department of Electronic & Telecommunication Engineering is located next to the statue of the Lord Buddha in the University of Moratuwa

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Cover Page Story

Printed circuit boards have changed in various ways since its inception. Enormous developments happened throughout its lifespan, which has made circuit boards useful and essential in modern-day, where technology has a significant impact on our lives. At the initial iteration, in the 1920s, almost any material such as wood used with flat wires, nuts, and bolts to build a circuit board. A remarkable improvement marked in the 1960s by shifting towards various resins and other suitable materials to produce single-sided PCBs. Later on, in the 1990s more complex, and technically advanced PCBs became popular. These include multi-layer, flexible, and rigid PCBs, and the trend moved from through-hole component selection to surface mount components.

Similarly, the Internet of Things, the fourth industrial revolution, has already started to evolve from connected cars and smart homes to wearable devices and smart cities, giving birth to abundant opportunities to share a common theme around many disciplines like telecommunication, computing, and electronics. This emerging technology would change the way humans interact with machines and lead the way to a hi-tech machine-to-machine interaction.

Along with these technologies, Artificial Intelligence (AI) plays a central role in terms of efficiency in the workplace by taking over repetitive or dangerous tasks and frees up the human workforce to do tasks that involve creativity and empathy between others, which humans are best equipped. The application of AI in security enhancement, decision making, and predictions in the economy, entertainment to driverless cars shapes the future and emphasizes the power of AI.

This year in the cover we have featured the emerging collaboration of distinctive fields that are going to revolutionize the world and impact Sri Lanka with many aspects, which, as a department, we thrive to champion and bolster.

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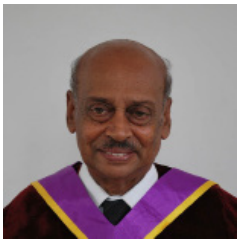

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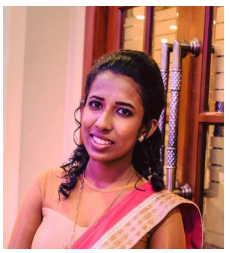

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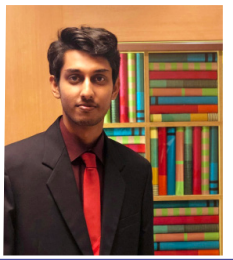

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Equipment and Facilities

Analog Electronics Laboratory

Analog electronics laboratory provides students a basic understanding of electronic circuits, characteristics of electronic devices and aids in the art of recording data. It houses a variety of test equipment including oscilloscopes, signal generators, counters, digital multimeters and power supplies. The facilities in the laboratory could be used not only for manditory laboratory sessions but also for project work and self learning.

Technical Officer: Mr. Sameera Chinthaka
Ext.: 3356

Computer Laboratory

The computer laboratory consists of over 20 personal computers for students and many servers for services and advanced computing. The local area network links all the laboratories and staff rooms and has internet facility through the university/ LEARN network. Each student has a user profile and an e-mail account which can be accessed from anywhere through secure shell. The computer laboratory is used by the undergraduate students for their assignments project work, internet browsing, e-mail and other computational needs. The entire department including class rooms is covered by a wireless network.

Technical Officer: Mr. Sanjeewa Fernando
Ext.: 3347

Digital Electronics/ Project Laboratory

This laboratory gives students hands-on experience with microprocessor hardware, software design concepts, their applications and provides facilities to investigate the architecture of microprocessors and associated systems. Students working in this laboratory utilize Hewlett-Packard design/development systems, logic analyzers, programmable logic development systems, and microprocessor trainers. A variety of advanced test equipment such as digital storage oscilloscopes, digital multimeters and PC coupled instrumentation are available for testing. The digital electronics/ project laboratory provides facilities for automatic testing of electronic circuit design and study of environmental effects on circuit and component operation.

Technical Officer: Mr. Thisara Wickramasinghe
Ext.: 3380

Microwave Laboratory

The microwave laboratory is used for the design and implementation of microwave communication systems that are used in the industry. Students working in this lab have the opportunity to learn the concepts of design and applications through hands-on experience. The laboratory experience is devoted to microwave generation, transmission and reception. Students will construct circuits that will demonstrate the basic principals involved in communications. Standard electronic instruments are used for construction and adjustment of various projects.

Technical Officer: Mr. Weditha Dissanayake
Ext.: 3360

Intelligent Machines Laboratory and UAV Research Laboratory

This laboratory is mainly used to handle robotics and automation related activities. It houses development boards for power devices, micro-controller testing and other devices such as a multitude of sensors and mechanical equipment. The laboratory sponsors many national and international robotics competitions. The laboratory space has been recently expanded to include research related to Unmanned Aerial Vehicles (UAVs).

Technical Officer: Mr. Sanjeewa Fernando
Ext.: 3363

Postgraduate Laboratory

The Postgraduate laboratory is equipped with a variety of modern industrial devices and equipment such as logic analyzers, network analyzers and spectrum analyzers. This laboratory also serves as a workspace for postgraduate students, to carry out their research work. Industry instrument testing, designing and consultancy services are done in this laboratory.

Technical Officer: Mr. Chinthaka Ranawaka
Ext.: 3357

Telecommunication Laboratory

This laboratory provides students an understanding of the basic concepts of communication circuits to achieve modulation and detection of radio signals. Students will construct circuits that will demonstrate the basic principals involved in communications. Standard electronic instruments are used in construction and adjustment of the various projects. The telecommunication laboratory is equipped with most of the modern equipment in the telecommunication field. A sweep generator test bench is available to measure single tuned and double tuned amplifiers. Spectrum analyzers are used to measure amplitude and frequency modulation. Students can utilize the wireless and land telephone systems implemented inside the laboratory for their studies.

Technical Officer: Mr. Chinthaka Ranawaka
Ext.: 3358

Wet Experiment Laboratory

The Wet Experiment Laboratory was formed in 2015 to provide undergraduate and postgraduate students the opportunity to do multi-disciplinary experiments that involve fluids. These include the application of electronics and control concepts to fluid processes. It also facilitates the study of biological organisms for biotechnology and biomimetic innovation in electronics, automation and robotics. The projects carried out are mainly self-innovation projects, undergraduate research projects, final year projects and postgraduate research projects. Relevant laboratory classes on industrial automation and control theory are also conducted in this laboratory.

Technical Officer: Mr. Thisara Wickramasinghe
Ext.: 3365

Electronic Workshop

With experienced engineers and technicians, and equipped with modern facilities, the electronic workshop provides a great support for undergraduate studies and projects. Students utilize the workshop to get hands on experience in good soldering practice and to build and test circuits for project work. Instruments available in the workshop include winding machines, oscilloscopes, de soldering stations, PCB drilling machines, hot air soldering gun, projects boards for testing and magnifying glasses. Industrial instrument repairing and designing are done under engineering consultancy by engineers in the electronic workshop.

Technical Officer: Mr. Weditha Dissanayake
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ENTC Auditorium

With a capacity of 120, the Department auditorium is the main lecture hall in the department. Most of its new facilities are there thanks to the 2002/2003 batch of the department and the World Bank HETC project. Apart from the lectures, it facilitates official events, meetings and other special gatherings of the department.

Living Space for Students

Students immensely benefit from the “living space” on the mezzanine floor. Inspired by the Think Lab, it provides students a space to engage in interactive and collaborative learning.

Using Facilities

The Department of Electronic and Telecommunication Engineering conducts its scheduled academic work from 8.00 am to 6.00 pm. The additional lecture hours or practical sessions can be arranged under the permission of the lecturer in-charge. Prior arrangements should be made with the instructor and the technical officer of the relevant lab, whenever there is a need to re-schedule the practical sessions.

Computer laboratory (1st floor) is open to the students of the department from 8.30 am to 4.30 pm. On request the opening hours can be extended for academic work. All the other laboratories follow a scheduled time table while arranging the practical sessions.

Students are allowed to use the equipment of the laboratories at any time, with the permission from the lecturer and the technical officer of the laboratory. For the final year project purposes, special arrangements regarding the usage of the laboratories can be made with the prior approval from the head of department.

Code of Conduct for Laboratories

Guidelines for Laboratory Sessions

- √ Be punctual.
- √ Keep your bags and shoes in the appropriate racks outside the laboratory.
- √ Ensure that all equipment required for the practical is available.
- √ Maintain a quiet environment.
- √ Please raise your hand to get the attention of the instructor if you have any doubt during the laboratory session.
- √ Arrange all laboratory equipment in their appropriate places after the end of the session. Switch off the power of all the equipment that you have switched on, at the end of the practical session.
- √ Line up the chairs/stools before you leave the laboratory.

- **Ensure that you have gone through the pre-lab document before coming for the practical.**
- **Fill the on-lab document while doing the practical, and get the stamp of the laboratory and the signature of the instructor in charge.**
- **Workout the post-lab document and submit it together with the on-lab document in the next practical session.**

Code of Conduct for the Computer Laboratory

1. No student should use another student's login account. If found, that login account will be disabled.
2. All students must sign in and out in the register kept at the computer laboratory if required.
3. Volume of the speakers should be low enough not to disturb others.
4. Computers should not be locked when not in use.
5. Computers should be shut down after use.
6. Lab is open from 8.00 am. to 4.30 pm. If students need to use the lab after 4.30 pm., a prior arrangement will be made on request.

Life at the Department of Electronic and Telecommunication Engineering

Choosing your specialization builds a foundation for your future career. However to excel in your professional life you need to balance your work with many other activities which will build your character. In our lecture halls and laboratories you will learn new concepts and accumulate knowledge to earn the qualification you seek. While appreciating ones own major, the department encourages its student body to seek, understand and appreciate other relevant areas in the engineering discipline as these provide the multi-disciplinary environment in which you will work after graduation.

Our undergraduate program of study is well planned to provide the most up to date knowledge. The department fosters a culture of self-learning, encouraging to look beyond what is taught in the lecture halls. In keeping with the departments policy of “teaching you to learn” we encourage you to get involved with the teaching learning process within the lecture hall and independently build knowledge outside the lecture hall. Our graduates are known to “hit the ground running” in the industry. They are known for their skillls and exemplary performance which is vindicated by the positive employer feedback on our graduates. The department maintains flexible hours when it comes to laboratories being used for academic activities.

We encourage you to use the facilities to investigate and practice the theories taught in the lectures so that you may enhance your ability to “do more with what you know”.

While you are being trained in academic activities you are encouraged to take part in the activities of the e-club, sports activities within the university, join clubs and organizations in the university, and do other recreational activities which make you a well rounded person. These activities will help you to develop aesthetic talents, organizational abilities and communication skills to become a graduate who can face the future with confidence. Activities such as the “Tronix Nite”, TPL cricket match, e-Care, and exhibitions the undergraduates organize are very good examples of how our students improve their soft skills. The department encourages you to engage in at least 20 hours of social responsibility activities each year and will support you in any way possible to identify and organize such activities.

Your time at the department will be made easier and more fruitful if you plan, prepare and persevere. Many students will find it hard to balance their academic activities and other relevant activities if you fail to plan ahead.

As a young graduate, one day you will be called upon to have precise time management capabilities, ability to prioritize tasks and to have commitment to complete the important tasks. In our capacity, the program at our department is designed to inculcate these good values and ensure these will become habits in the future.

Once you are in our department, we will take good care of you and do our best to ensure that your undergraduate life is a fruitful and enjoyable experience. It is our vision to produce a graduate who is technically competent and socially responsible and be an asset to any organization.

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Curriculum and Modules

Electronic and Telecommunication Engineering

Course Curriculum

The information given below outlines the course curriculum for the Electronic and Telecommunication Engineering specialization.

The course unit selections indicated for a particular semester is for guidance of students and academic advisors only. All units shown may not be offered in a particular year. The syllabi of course units offered by other departments are available with the curriculum for that particular department.

The following descriptors are used:

C - Core Modules
E - Elective Modules
O - Optional Modules

Summary of Normal Minimum Credit Requirements

Overall GPA credits = 137 credits
Overall Non-GPA credits = 13 credits

Definition of a Credit**

One credit is equivalent to 15 hours of lectures or 30-45 hours of laboratory studies or 45 hours of field studies/clinical work or minimum of 90 hours of industrial training.

Graduation Credit Requirement

Semester/ Term	GPA Credits Normal *	Non GPA Credits
Semester 1	15.0	1.0
Semester 2	17.0	2.0
Semester 3	22.0	-
Semester 4	20.5	1.0
Semester 5	19	-
Industrial Training	-	6.0
Semester 6B	9.0	3.0
Semester 7	18.0	-
Semester 8	16.5	-

**** Irrespective of the norm, maximum credits a student could register for a Semester is 26***

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Semester 1									
MA1013	Mathematics	C	3.0	1/1	3.0				
CS1032	Programming Fundamentals	C	2.0	3/1	3.0				
ME1032	Mechanics	C	2.0	3/4	2.0				
MT1022	Properties of Materials	C	2.0	3/4	2.0				
CE1022	Fluid Mechanics	C	2.0	3/4	2.0				
EE1013	Electrical Engineering	C	2.0	3/4	2.0				
EL1012	Language Skill Enhancement I	C	-	3/1	1.0		15.0		
MN1012	Engineering in Context	C	1.0	-		1.0		1.0	
				Total for Semester 1			15.0	1.0	16.0
Semester 2									
MA1023	Methods of Mathematics	C	3.0	1/1	3.0				
EN1013	Electronics I	C	3.0	-	3.0				
EN1053	Introduction to Telecommunications	C	3.0	-	3.0				
EN1060	Signals and Systems	C	3.0	-	3.0				
EN1093	Laboratory Practice I	C	-	9/1	3.0				
EN1970	Communication Skills	C	1.0	3/1	2.0		17.0		
EN1070	Electronics Product Design and Manufacture	C	2.0	3/1		3.0		3.0	
MN1030	Entrepreneurship Skill Development	O	0.5	3/2		1.0			
				Total for Semester 2			17.0	3.0	20.0

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Semester 3									
MA2013	Differential Equations	C	2.0	-	2.0				
MA2023	Calculus	C	2.0	-	2.0				
EN2013	Electronics II	C	3.0	-	3.0				
EN2040	Random Signal Processing	C	2.0	-	2.0				
EN2053	Communication Systems and Networks	C	3.0	-	3.0				
EN2030	Fundamentals of Computer Organization	C	3.0	-	3.0				
EN2090	Laboratory Practice II	C	-	9/1	3.0				
EE2093	Theory of Electricity	C	2.0	-	2.0		20.0		
EN2532	Robot Design and Competition	E	1.0	3/1	2.0				
ME1822	Basic Engineering Thermodynamics	E	1.5	3/2	2.0				
ME2122	Engineering Drawing and Computer Aided Modelling	E	2.0	3/1	3.0		2.0		
MN1030	Entrepreneurship Skill Development	O	0.5	3/2		1.0			
				Total for Semester 3			22.0	-	22.0
Semester 4									
MA2033	Linear Algebra	C	2.0	-	2.0				
EN2110	Electronics III	C	3.0	3/1	4.0				
EN2073	Analog and Digital Communication	C	3.0	3/1	4.0				
EN2083	Electromagnetics	C	3.0	3/1	4.0				
EN2570	Digital Signal Processing	C	2.0	3/1	3.0		17.0		
EN2962	Fundamentals of Image Processing and Machine Vision	E	2.0	3/2	2.5				
EN2560	Internet of Things Design and Competition	E	1.0	3/1	2.0				
BM2800	Introduction to Biomedical Engineering	E	2.0	-	2.0				
CS2022	Data Structures and Algorithms	E	2.0	3/2	2.5				
CS2832	Modular Software Development	E	2.0	3/2	2.5				
EE2013	Electrical Machines & Drives	E	2.0	-	2.0				
MA2053	Graph Theory	E	2.0	-	2.0		4.0		
MN2010	Entrepreneurial Leadership	O	1.5	3/2	2.0				
				Total for Semester 4			21.0		21.0

Code	Module Name	Category Assign.	Lectures hrs/week	Lab/ hrs/week	Credits GPA	Credits NGPA	Norm GPA	Norm NGPA	Total
Semester 5									
EN3030	Circuits and Systems Design	C	3.0	3/1	4.0				
EN3053	Digital Communication I	C	3.0	3/1	4.0				
EN3143	Electronic Control Systems	C	2.0	3/1	3.0				
CS3032	Computer Networks	C	2.0	3/1	3.0				
EN3023	Electronic Design Realization	C	2.0	3/1	3.0		17.0		
MA3013	Applied Statistics	E	2.0	-	2.0				
MA3023	Numerical Methods	E	2.0	-	2.0		2.0		
MN3042	Business Economics & Financial Accounting	E	3.0	-	3.0				
MN3052	Industrial Management & Marketing	E	2.5	3/2	3.0		3.0		
MN3010	Multidisciplinary Design, Innovation and Venture Creation	O	1.5	3/2	2.0				
				Total for Semester 5			22.0		22.0
Industrial Training									
EN3992	Industrial Training	C	-	-		6.0		6.0	
				Total for Industrial Training				6.0	6.0
Semester 6B									
EN3110	Electronic Devices	E	3.0	3/1	4.0				
DE1xxx	Humanities Electives I	E	2.0	-	2.0				
DE2xxx	Humanities Electives II	E	2.0	-	2.0		4.0		
EN3223	Electronic Manufacturing Systems	E	3.0	-	3.0				
EN3240	Embedded Systems Engineering	E	2.0	3/1	3.0				
EN3250	Internet of Things	E	2.0	3/1	3.0				
EN3370	Traffic Engineering	E	2.0	3/1	3.0				
EN3532	Electronic Instrumentation	E	2.0	3/1	3.0		3.0		
EN3210	Self Initiated Innovation	E	-	-		3.0			
EN3900	Seminar	E	2.0	-		2.0		2.0	
				Total for Semester 6			7.0	2.0	

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Semester 7									
EN4202	Project*	C	-	-	4.0				
EN4820	Ethics & Legal Fundamentals	C	1.0	-	1.0				
EN4932	Technical and Scientific Writing	C	0.5	3/2		1.0	5.0	1.0	
EN4063	Digital IC Design	E	2.0	3/1	3.0				
EN4213	Power Electronics	E	2.0	3/1	3.0				
EN4053	Digital Communications II	E	2.0	3/1	3.0				
EN4313	Telecommunication Core Networks	E	2.0	3/1	3.0				
EN4363	Microwave Communications	E	2.0	3/1	3.0				
EN4553	Machine Vision	E	2.0	3/1	3.0				
EN4563	Robotics	E	2.0	3/1	3.0				
EN4922	Research Project**	E	-	-	2.5				
BM4111	Medical Electronics and Instrumentation	E	2.0	3/1	3.0		6.0		
BM4301	Medical Image Processing	E	2.0	3/1	3.0				
BM4321	Genomic Signal Processing	E	2.0	3/1	3.0				
MA4013	Linear Models and Multivariate Statistics	E	3.0	-	3.0				
MA4033	Time Series and Stochastic Processes	E	3.0	-	3.0				
MA4023	Operational Research	E	3.0	-	3.0				
MA4053	Neural Network and Fuzzy Logic	E	3.0	-	3.0		3.0		
MN450	Project Management	E	2.0	-	2.0				
MN4062	Organizational Behaviour and Management	E	2.0	-	2.0				
MN4132	Consumer and Industrial Marketing	E	2.0	-	2.0				
MN4122	Human Research Management and Industrial Relations	E	2.0	-	2.0				
MN4042	Technology Management	E	2.0	-	2.0				
MN4022	Engineering Economics	E	2.0	-	2.0				
MN4030	Strategic Enterprise Management	E	1.5	3/2	2.0				
MN3020	Entrepreneurship Business Basics	E	2.0	3/1	3.0		2.0		
				Total for Semester 7			16.0	1.0	17.0

Code	Module Name	Category	Lectures hrs/week	Lab/ Assign. hrs/week	Credits GPA	Credits NGPA	Norm GPA	Norm NGPA	Total
Semester 8									
EN4202	Project*	C	-	-	6.0		6.0		
EN4020	Advanced Digital Systems	E	2.0	3/1	3.0				
EN4233	Industrial Electronics and Automation	E	2.0	3/1	3.0				
EN4283	Electronic Application in Renewable Energy	E	2.0	3/1	3.0				
EN4430	Analog IC Design	E	2.0	3/1	3.0				
EN4323	Optical Fibre Communications	E	2.0	3/1	3.0				
EN4333	Microwave Engineering	E	2.0	3/1	3.0				
EN4353	Radar and Navigation	E	2.0	3/1	3.0				
EN4383	Wireless and Mobile Communications	E	2.0	3/1	3.0				
EN4393	Information Theory	E	2.0	3/1	3.0				
EN4403	Mobile Computing	E	2.0	3/1	3.0				
EN4420	Advanced Signal Processing	E	2.0	3/1	3.0				
EN4573	Pattern Recognition and Machine Intelligence	E	2.0	3/1	3.0				
EN4583	Advances in Machine Vision	E	2.0	3/1	3.0				
EN4593	Autonomous Systems	E	2.0	3/1	3.0				
EN4922	Research Project**	E	-	-	2.5		6.0		
MA4013	Linear Models and Multivariate Statistics	E	3.0	-	3.0				
MA4033	Time Series and Stochastic Processes	E	3.0	-	3.0				
MA4023	Operational Research	E	3.0	-	3.0				
MA4053	Neural Network and Fuzzy Logic	E	3.0	-	3.0		3.0		
MN4122	Human Resource Management and Industrial Relations	E	2.0	-	2.0				
MN4042	Technology Management	E	2.0	-	2.0				
MN4072	Small Business Management and Entrepreneurship	E	2.0	-	2.0				
		E	2.0	-	2.0				
MN4022	Engineering Economics	E	2.0	-	2.0				
MN4052	Project Management	E	2.0	-	2.0				
MN4092	Management Skills Development	E	2.0	-	2.0				
MN4112	Production and Operations Management	E	2.0	-	2.0				
MN4010	Business Plan Development	E	1.5	3/2	2.0				
MN4170	Global Entrepreneurship	E	1.5	3/2	2.0		2.0		
				Total for Semester 8			17.0		17.0

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Module lineup for the Entrepreneurship Minor									
MN1030	Entrepreneurship Skill Development	C	1.0	3/1		2.0		2.0	
MN2010	Entrepreneurial Leadership	C	1.5	3/2	2.0				
MN3010	Multidisciplinary Design, Innovation and Venture Creation	C	1.5	3/2	2.0				
MN3020	Entrepreneurship Business Basics	C	2.0	3/1	3.0				
MN4010	Business Plan Development	C	1.5	3/2	2.0		9.0		
MN4022	Engineering Economics	E	2.0	-	2.0				
MN4042	Technology Management	E	2.0	-	2.0				
MN4112	Production and Operations Management	E	2.0	-	2.0				
MN4030	Strategic Enterprise Management	E	1.5	3/2	2.0				
MN4170	Global Entrepreneurship	E	1.5	3/2	2.0		2.0		
				Total for all Semesters			11.0	2.0	13.0

Notes

* A total of 10 credits are distributed in Semester 7, Semester 8.

** If “Research Project” is taken, 2.5 credits each from Semester 7 and Semester 8 is considered to be covered.

Curriculum and Modules
Biomedical Engineering

Course Curriculum

The information given below outlines the course curriculum for the Biomedical Engineering specialization.

The course unit selections indicated for a particular semester is for guidance of students and academic advisors only. All units shown may not be offered in a particular year. The syllabi of course units offered by other departments are available with the curriculum for that particular department.

The following descriptors are used:

C - Core Modules
E - Elective Modules
O - Optional Modules

Summary of Normal Minimum Credit Requirements

Overall GPA credits = 137 credits
Overall Non-GPA credits = 13 credits

Definition of a Credit

One credit is equivalent to 15 hours of lectures or 30-45 hours of laboratory studies or 45 hours of field studies/clinical work or minimum of 90 hours of industrial training.

Graduation Credit Requirement

Semester/ Term	GPA Credits Normal *	Non GPA Credits
Semester 1	15.0	1.0
Semester 2	17.0	2.0
Semester 3	22.0	-
Semester 4	20.5	1.0
Semester 5	19	-
Industrial Training	-	6.0
Semester 6B	9.0	3.0
Semester 7	18.0	-
Semester 8	16.5	-

**** Irrespective of the norm, maximum credits a student could register for a Semester is 26***

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Semester 1									
MA1013	Mathematics	C	3.0	1/1	3.0				
CS1032	Programming Fundamentals	C	2.0	3/1	3.0				
ME1032	Mechanics	C	2.0	3/4	2.0				
MT1022	Properties of Materials	C	2.0	3/4	2.0				
CE1022	Fluid Mechanics	C	2.0	3/4	2.0				
EE1013	Electrical Engineering	C	2.0	3/4	2.0				
EL1012	Language Skill Enhancement I	C	-	3/1	1.0		15.0		
MN1012	Engineering in Context	C	1.0	-		1.0		1.0	
				Total for Semester 1			15.0	1.0	16.0
Semester 2									
MA1023	Methods of Mathematics	C	3.0	1/1	3.0				
BM1011	Engineering in Medicine and Biology	C	1.0	3/1		2.0			
EN1013	Electronics - I	C	3.0	-	3.0				
EN1053	Introduction to Telecommunications	C	3.0	-	3.0				
EN1060	Signals and Systems	C	3.0	-	3.0				
EN1093	Laboratory Practice - I	C	-	9/1	3.0				
EN1970	Communication Skills	C	1.0	3/1	2.0		17.0	2.0	
MN1030	Entrepreneurship Skill Development	O	0.5	3/2		1.0			
				Total for Semester 2			17.0	2.0	19.0

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Semester 3									
MA2013	Differential Equations	C	2.0	-	2.0				
MA2023	Calculus	C	2.0	-	2.0				
EN2013	Electronics II	C	3.0	-	3.0				
EN2040	Random Signals and Processes	C	2.0	-	2.0				
BM2011	Human Anatomy and Physiology I	C	3.0	-	3.0				
EN2030	Fundamentals of Computer Organization and Design	C	3.0	-	3.0				
EN2090	Laboratory Practice - II	C	-	9/1	3.0				
EE2093	Theory of Electricity	C	2.0	-	2.0		20.0		
ME1822	Basic Engineering Thermodynamics	E	1.5	3/2	2.0				
ME2122	Engineering Drawing and CAM	E	2.0	3/1	3.0		2.0		
EN2532	Robot Design and Competition	O	1.0	3/1	2.0				
MN1030	Entrepreneurship Skill Development	O	0.5	3/2		1.0			
				Total for Semester 3			22.0	-	22.0
Semester 4									
MA2033	Linear Algebra	C	2.0	-	2.0				
EN2110	Electronics - III	C	3.0	3/1	4.0				
EN2083	Electromagnetics	C	3.0	3/1	4.0				
EN2570	Digital Signal Processing	C	2.0	3/1	3.0				
BM2020	Human Anatomy and Physiology II	C	2.0	3/2	2.5				
BM2101	Analysis of Physiological Systems	C	2.0	3/1	3.0				
BM2900	Field Visit	C	-	-		1.0	18.5	1.0	
EN2550	Fundamentals of Image Processing and Machine vision	E	2.0	3/1	3.0				
CS2022	Data Structures and Algorithms	E	2.0	3/2	2.5				
CS2832	Modular Software Development	E	2.0	3/2	2.5				
MA2053	Graph Theory	E	2.0	-	2.0		2.0		
MN2010	Entrepreneurial Leadership	O	1.5	3/2	2.0				
				Total for Semester 4			20.5	1.0	21.5

Code	Module Name	Category Assign.	Lectures hrs/week	Lab/ hrs/week	Credits GPA	Credits NGPA	Norm GPA	Norm NGPA	Total
Semester 5									
BM3121	Medical Imaging	C	3.0	3/1	4.0				
EN3030	Circuits and Systems Design	C	3.0	3/1	4.0				
EN3143	Electronic Control Systems	C	2.0	3/1	3.0		11.0		
CS3032	Computer Networks	E	2.0	3/1	3.0				
EN3023	Electronic Design Realization	E	2.0	3/1	3.0		3.0		
MA3013	Applied Statistics	E	2.0	-	2.0				
MA3023	Numerical Methods	E	2.0	-	2.0		2.0		
MN3042	Business Economics & Financial Accounting	E	3.0	-	3.0				
MN3052	Industrial Management & Marketing	E	2.5	3/2	3.0		3.0		
MN3010	Multidisciplinary Design, Innovation and Venture Creation	O	1.5	3/2	2.0				
				Total for Semester 5			19.0		19.0
Industrial Training									
BM3990	Industrial Training*	C	-	-		6.0		6.0	
				Total for Industrial Training				6.0	6.0
Semester 6B									
BM3180	Scientific Communications for BME	C	1.0	3/1	2.0				
BM3190	Biostatistics and Ethics for BME	C	-	3/1		1.0			
EN3900	Seminar	C	2.0	-		2.0	2.0	3.0	
DE1xxx	Humanities Electives I	E	2.0	-	2.0				
DE2xxx	Humanities Electives II	E	2.0	-	2.0		4.0		
EN3110	Electronic Devices	E	2.0	3/1	3.0				
EN3240	Embedded Systems Engineering	E	2.0	3/1	3.0				
EN3370	Traffic Engineering	E	2.0	3/1	3.0				
EN3532	Electronic Instrumentation	E	2.0	3/1	3.0				
EN3210	Self Initiated Innovation	E	-	-	3.0		3.0		
				Total for Semester 6			9.0	3.0	12.0

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Semester 7									
BM4200	Research Project*	C	-	-	4.0				
BM4111	Medical Electronics and Instrumentation	C	2.0	3/1	3.0		7.0		
BM4151	Biosignal Processing	E	2.0	3/1	3.0				
BM4301	Medical Image Processing	E	2.0	3/1	3.0				
EN4321	Genomic Signal Processing	E	2.0	3/1	3.0		3.0		
EN4603	Digital IC Design	E	2.0	3/1	3.0				
EN4213	Power Electronics	E	2.0	3/1	3.0				
EN4553	Machine Vision	E	2.0	3/1	3.0				
EN4563	Robotics	E	2.0	3/1	3.0		3.0		
MA4013	Linear Models and Multivariate Statistics	E	3.0	-	3.0				
MA4033	Time Series and Stochastic Processes	E	3.0	-	3.0				
MA4023	Operational Research	E	3.0	-	3.0				
MA4053	Neural Network and Fuzzy Logic	E	3.0	-	3.0		3.0		
MN4150	Project Management	E	2.0	-	2.0				
MN4062	Organizational Behaviour and Management	E	2.0	-	2.0				
MN4132	Consumer and Industrial Marketing	E	2.0	-	2.0				
MN4122	Human Resource Management and Industrial Relations	E	2.0	-	2.0				
MN4042	Technology Management	E	2.0	-	2.0				
MN4022	Engineering Economics	E	2.0	-	2.0				
MN4030	Strategic Enterprise Management	E	1.5	3/2	2.0				
MN3020	Entrepreneurship Business Basics	E	2.0	3/1	3.0		2.0		
				Total for Semester 7			18.0	1.0	19.0

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Semester 8									
BM4200	Research Project*	C	-	-	6.0		6.0		
BM4500	Biomechanics	E	2.0	3/2	2.5				
BM4521	Rehabilitation Engineering	E	2.0	3/2	2.5				
BM4600	Biomaterials	E	2.0	3/2	2.5				
BM4620	Biotechnology	E	2.0	3/2	2.5		2.5		
EN4020	Advanced Digital Systems	E	2.0	3/1	3.0				
EN4233	Industrial Electronics and Automation	E	2.0	3/1	3.0				
EN4283	Electronic Application in Renewable Energy	E	2.0	3/1	3.0				
EN4430	Analog IC Design	E	2.0	3/1	3.0				
EN4333	Microwave Engineering	E	2.0	3/1	3.0				
EN4393	Information Theory	E	2.0	3/1	3.0				
EN4403	Mobile Computing	E	2.0	3/1	3.0				
EN4420	Advanced Signal Processing	E	2.0	3/1	3.0				
EN4573	Pattern Recognition and Machine Intelligence	E	2.0	3/1	3.0				
EN4583	Advances in Machine Vision	E	2.0	3/1	3.0				
EN4593	Autonomous Systems	E	2.0	3/1	3.0		3.0		
MA4013	Linear Models and Multivariate Statistics	E	3.0	-	3.0				
MA4033	Time Series and Stochastic Processes	E	3.0	-	3.0				
MA4023	Operational Research	E	3.0	-	3.0				
MA4053	Neural Network and Fuzzy Logic	E	3.0	-	3.0		3.0		
MN4122	Human Resource Management and Industrial Relations	E	2.0	-	2.0				
MN4042	Technology Management	E	2.0	-	2.0				
MN4072	Small Business Management and Entrepreneurship	E	2.0	-	2.0				
		E	2.0	-	2.0				
MN4022	Engineering Economics	E	2.0	-	2.0				
MN4150	Project Management	E	2.0	-	2.0				
MN4092	Management Skills Development	E	2.0	-	2.0				
MN4112	Production and Operations Management	E	2.0	-	2.0				
MN4010	Business Plan Development	E	1.5	3/2	2.0				
MN4170	Global Entrepreneurship	E	1.5	3/2	2.0		2.0		
				Total for Semester 8			16.5		16.5

Code	Module Name	Category	Lectures	Lab/ Assign.	Credits		Norm		
			hrs/week	hrs/week	GPA	NGPA	GPA	NGPA	Total
Module lineup for the Entrepreneurship Minor									
MN1030	Entrepreneurship Skill Development	C	1.0	3/1		2.0		2.0	
MN2010	Entrepreneurial Leadership	C	1.5	3/2	2.0				
MN3010	Multidisciplinary Design, Innovation and Venture Creation	C	1.5	3/2	2.0				
MN3020	Entrepreneurship Business Basics	C	2.0	3/1	3.0				
MN4010	Business Plan Development	C	1.5	3/2	2.0		9.0		
MN4022	Engineering Economics	E	2.0	-	2.0				
MN4042	Technology Management	E	2.0	-	2.0				
MN4112	Production and Operations Management	E	2.0	-	2.0				
MN4030	Strategic Enterprise Management	E	1.5	3/2	2.0				
MN4170	Global Entrepreneurship	E	1.5	3/2	2.0		2.0		
				Total for all Semesters			11.0	2.0	13.0

Notes

* A total of 10 credits are distributed in Semester 7, Semester 8.

Semester 1 Module Information

Module Code	MA1013	**Module Title**	Mathematics			
Credits	3.0	**Hours/Week**	**Lectures**	3	**Pre/Co-requisites**	-
GPA/NGPA	GPA		**Lab/Assignments**	1/1		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Use discrete mathematical structures such as logic and let theory in applications.					
2.	Use algebraic structures such as real numbers, vectors and matrices in applications.					
3.	Apply the basic concepts of limits, differentiation, and integration in engineering applications.					
Outline Syllabus						
1.	**Logic and Set Theory:** Propositions, truth tables, symbolic statements, conditional connectives, quantifiers. Techniques of proof: direct, contradiction, induction, pigeonhole principle. Sets, cardinality, Cartesian product, ordered pairs. Relations, functions, Boolean algebra: disjunctive and conjunctive normal forms, logic gates, Karnaugh maps, minimization, and applications.					
2.	**Real Analysis:** Real number system, supremum and infimum, completeness axiom. Basic functions: polynomial, exponential, trigonometric, hyperbolic and their inverses. Limit of a function, continuity, differentiability, derivatives. Rolle's theorem, mean value theorem, L' Hospital's rule. Sequences and series of real numbers. Tests for convergence of sequences and series.					
3.	**Vectors, and Matrices:** Vector algebra, vector product, scalar product, scalar triple product, vector triple product. Equations of lines and planes. Matrix operations, transpose, adjoint and inverse of a matrix, echelon forms, rank, determinants. Systems of linear equations.					

Module Code	CS1032	Module Title	Programming Fundamentals			
Credits	3.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Device algorithms to solve simple computational problems.
2.	Develop programs from algorithms using a high-level programming language (e.g., Python).
3.	Develop programs for simple control applications using embedded hardware platforms.
Outline Syllabus	
1.	**Introduction to Computing (2 h)**
2.	**Python: Introduction, Operators, Expressions (2 h)**
3.	**Python: Selection Control Structures (2 h)**
4.	**Python: Loop Control Structures (2 h)**
5.	**Python: Lists (2 h)**
6.	**Python: Functions (2 h)**
7.	**Data Representation (2 h)**
8.	**Problem Solving (6 h)**
9.	**Computer System & Hardware (6 h)**

Module Code	EN1970	Module Title	Mechanics			
Credits	2.0	Hours/Week	Lectures	1/2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/4		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Calculate rigid body forces and motions.
2.	Perform simple mechanics experiments.
3.	Understand the basic concepts of dynamics.
4.	Model and solve basic systems in dynamics.
Outline Syllabus	
1.	Properties of plane areas.
2.	Internal forces and principle of superposition.
3.	Determination of forces in assemblies of rigid bodies.
4.	Kinematics of particles and rigid bodies, 2D link mechanisms.
5.	Kinetics of particles and rigid bodies, work, and energy methods.
6.	Mechanical vibrations (free vibrations of single degree of freedom systems) .

Module Code	MT1022	Module Title	Properties of Materials			
Credits	2.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/4		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Recognize the structure engineering materials.
2.	Assess the properties of engineering materials.
3.	Relate the properties of materials to their structure.

Outline Syllabus	
1.	**Recognize the Structure of Engineering Materials:** Introduction to engineering materials. Structure of atoms, atomic theories, atomic bonding in materials. Crystal structures and defects. Introduction to nanomaterials.
2.	**Assess the Properties of Engineering Materials**
3.	**Relate the Properties of Materials to their Structure:** Mechanical properties of materials. Electrical properties of materials. Corrosion of metals. Radioactivity and nuclear properties.

Module Code	CE1022	Module Title	Fluid Mechanics			
Credits	2.0	Hours/Week	Lectures	2.5	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/4		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe fluid properties and characteristics of fluids in reference to engineering practice and related applications.
2.	Demonstrate hydrostatic forces on structures such as dams and radial gates and analyse the stability of floating vessels.
3.	Apply concepts of conservation of mass, energy, and momentum of fluids in applications such as determining discharge and energy losses in pipelines and forces on bends/vanes.

Outline Syllabus	
1.	**Introduction:** Historical development of fluid mechanics; applications of fluid mechanics in engineering practice (irrigation, hydropower, water supply, pumps, and turbines, etc.).
2.	**Fluid Properties:** Characteristics of fluids- including density, specific weight, relative density, and viscosity; continuum concept.
3.	**Hydrostatic Pressure:** Basic equations, pressure and piezometric heads, absolute and gauge pressures; measurement of pressure, pressure rating of pipes; hydrostatic thrust on plane and curved surfaces; centre of pressure and related applications.
4.	**Buoyancy:** Up thrust on submerged bodies, Archimedes principle, centre of buoyancy, stability of floating bodies- metacentric height.
5.	**Relative Equilibrium:** Relative equilibrium of fluids under linear acceleration; forced vortex motion.
6.	**Fluids in Motion:** Concepts of fluid flow, fluid kinematics; flow classification: laminar/turbulent flow; techniques of fluid flow analysis – conservation of mass (continuity), energy (Bernoulli) and momentum equations; applications – flow in pipes.
7.	**Hydraulic Machinery:** Basic introduction to pumps and turbines.

Module Code	EE1012	Module Title	Electrical Engineering			
Credits	2.0	Hours/Week	Lectures	1.5	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Use correct SI units.
2.	Project an overall picture of Electrical Engineering.
3.	Perform DC, AC, and transient calculations.
4.	Analyse complex alternating current circuits and give solutions.
5.	Apply different types of meters for electrical measurements.
6.	Draw up complete wiring circuit of a household and appreciate the importance of different protection.

Outline Syllabus	
1.	**SI Units**
2.	**Overview of Electrical Engineering**
3.	**Basic DC circuit analysis:** Circuit elements, circuit laws, circuit solutions.
4.	**Transient solution of simple RLC circuits**
5.	**AC Theory:** Phasor representation, complex representation, impedance, admittance, complex power and energy, power factor, AC circuit calculations.
6.	**Electrical Measurement:** Moving coil, moving iron and rectifier type meters, bridge methods, power, and energy meters, working principles.
7.	**Electrical Installations:** Fuses, MCBs, ELCBs, wires, complete household wiring circuit.

Module Code	EL1012	Module Title	Language Skills Enhancement I			
Credits	1.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify key ideas in a long text when read or a lecture as required in undergraduate studies.
2.	Express ideas in written form as required in undergraduate studies.
3.	Comprehend a long technical or non-technical text, as required in undergraduate studies.
4.	Express technical or non-technical ideas in clear writing as required in undergraduate studies.

Outline Syllabus	
1.	Listening to lectures, make predictions, listen for specific information, listen and give appropriate answers, ask and answer simple questions, prepare for and take part in a discussion, report the discussion, read and understand short texts, transfer information, generate ideas for writing tasks, create a plan for writing, question forms (1) – information questions (e.g. what, where, why.…), expressing & exchanging opinions, reporting verbs – subject, verb, object, verbs used in examinations/assignments – questions & answers, noun phrases (1) determiner + adjective + noun.
2.	Identify the features of academic language, describe dimensions of various objects, use symbols, numbers, signs, make simple presentations on a general topic, ask and answer questions from peers, discuss a technical passage with peers, read and understand a short descriptive text, understand simple information in an academic text, identify contextual references in a text, identify the type of language and features of language used for writing about dimensions, write a description on dimensions of objects, noun phrases (2) - adjective + noun, noun + prepositional phrase, sentence constructions - subject + verb + complement (noun/adjective), link verbs - verbs which connect subject & predicate, prepositional phrases - preposition + noun.
3.	Use a classification chart to take down notes, use abbreviations, signs, symbols, diagrams, tables etc. in notetaking while listening, recognise and practice signpost language, make a presentation using – a classification chart, a flow chart, sign-post language, discuss a technical passage with peers, use of classification language in academic texts, understand the main idea and the supporting details of an informative text, develop tree diagrams in taking short notes on classification / use classification to make notes, identify the type of language and features of the language used in classifications, write a description on classification of different objects, use levels of generalisation in writing classification, verb – noun transformation/noun–verb transformation, simple present tense – to describe about disciplines, events etc., general and specific classifications, sign-post language (1) & (2) – introducing and transition between points, identify cause effect relationship in listening texts, identify different steps in a process while listening, take a note of a process while listening, present a process using diagrams/power point presentations on different types of processes, read and understand language used in expressing cause and effect relationship, rephrase - read and understand language used in different types of processes, understand specific information in a passage, summarise, transfer information, take notes on a process, identify the type of language and features of the language used to show cause and effect relationship, plan & write a simple cyclic process, write different types of processes using appropriate markers, cause & effectlanguage (1) different structures, cause & effect relationships (2) use of conjunctions, cause & effect relationships (3) nouns, verbs, and prepositional phrases, the passive voice (1), sequence markers – first, then, next.
4.	Predict/anticipate the ideas to be expressed in a lecture, recognise and identify language of comparison and contrast, make informal presentations comparing, contrasting & evaluating definitions, present a topic using comparative and contrasting language, discuss different types of essay outlines, recognise and categorise expressions of similarities and differences, use language of comparison and contrast, write extended definitions which include comparison and contrast, organise ideas in a comparison and contrast essay, synthesise information from different sources, comparison and contrast language (1) grammatical categories, comparison and contrast language (2) subordinators, link verbs – verbs which connect subject & predicate, prepositional phrases – preposition + noun.

Module Code	MN1012	Module Title	Engineering in Context			
Credits	1.0	Hours/Week	Lectures	1	Pre/Co-requisites	-
GPA/NGPA	NGPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Recognize the scientific and social contexts in engineering profession.
2.	Identify the basic ingredients of professionalism in engineering.
3.	Explain the importance of economic, risk and safety issues for the engineering decisions.
4.	Describe the basic professional skills, ethics and concepts required for an engineer in industrial society.

Outline Syllabus	
1.	What is engineering and its relevance to society. Historical development of engineering and Sri Lankan engineering heritage (old and recent).
2.	Economic, risk and safety issues in engineering. Roles and responsibilities of a professional engineer in society and industry.
3.	Interaction of engineering with natural and built environment; engineering solutions for environmental problems.
4.	Sustainable engineering design, learning from failures.
5.	Skills of engineer in industrial environment (management, teamwork, communication).

Semester 2 Module Information

Module Code	EN1013	**Module Title**	Electronics I			
Credits	3.0	**Hours/Week**	**Lectures**	3	**Pre/Co-requisites**	-
GPA/NGPA	GPA		**Lab/Assignments**	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Design diode circuits.					
2.	Analyze DC biasing techniques of BJTs and FETs.					
3.	Design combinational logic circuits.					
4.	Analyze characteristics of logic families.					
Outline Syllabus						
1.	**Diodes and their Applications (8 h):** Diode characteristics, clipping and clamping circuits, rectifiers and smoothing, light emitters and light sensors, Zener diodes, DC power supply using diodes.					
2.	**Transistors and their Applications - BJT and FET (16 h):** Device structures and characteristics, biasing of transistors and Q-point analysis, analysis of DC load line, transistor as a switch /amplifier.					
3.	**Combinational Logic Circuits (8 h):** Logic gates and Boolean expressions, minimization of logic expressions, Karnaugh maps, design of combinational logic circuits.					
4.	**Logic Families (4 h):** Saturated unsaturated logics, TTL and CMOS, tri-state logics, fan in, fan out and power consumption of logic gates.					

Module Code	EN1054	Module Title	Introduction to Telecommunications			
Credits	3.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Recognize the historical evolution, the current status and future trends of the telecommunications industry.
2.	Explain how signals can be characterized, classify them into different types and identify their role in communications systems.
3.	Explain channels, possible impairments and their impact on communication system performance.
4.	Distinguish between different modulation and multiplexing schemes and illustrate their application in different scenarios.
5.	Describe how different types of switching schemes enable transmission of information over communication networks.
6.	Compare and contrast transmission media in terms of their characteristics and identify typical applications of each.
Outline Syllabus	
1.	**Introduction to Telecommunication Systems (4 h):** Typical functions of a communication system in block diagram form. Historical developments and current trends in telecommunications. Telecommunications regulatory activities.
2.	**Signals (4 h):** Classification as analog/digital, periodic/aperiodic, deterministic/ stochastic, energy/power. Time and frequency domain characterization. Signal sources and their characteristics. Digitization of analog signals.
3.	**Channels (6 h):** Channel bandwidth, noise and other impairments, impact and introduction to mitigation techniques, Signal-to-Noise ratio, and the use of decibels in power measurements. The information-carrying capacity of a channel.
4.	**Modulation and Multiplexing (14 h):** The need for modulation, classification of modulation techniques as continuous wave/pulse, amplitude/frequency/phase and analog/ digital. Amplitude and frequency modulation. Demodulation of AM and FM. Introduction to digital modulation schemes. Examples of applications of different modulation schemes. Introduction to broadband and multicarrier modulation schemes. The need for multiplexing and duplexing in telecommunication networks. Classification of multiplexing schemes as frequency division, time division, code division and their hybrids. Standard multiplexing hierarchies.
5.	**Switching (8 h):** Switching as an enabler for communication networks. Circuit switching and packet switching their characteristics and applications. Measurement of telecommunications traffic and its application to dimensioning of telecommunications systems.
6.	**Transmission media (6 h):** Guided transmission media and characteristics, unguided transmission, the radio spectrum, its usage and regulation, radio wave propagation. Different types of antennas, their characteristics and applications. Human exposure to electromagnetic radiation, health hazards and safety levels.

Module Code	EN1060	Module Title	Signals and Systems			
Credits	3.0	Hours/Week	Lectures		Pre/Co-requisites	
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Differentiate between continuous-time, discrete-time and digital signals, and techniques applicable to the analysis of each type.
2.	Use Fourier techniques to understand frequency domain characteristics of signals.
3.	Use appropriate theoretical principles for sampling and reconstruction of analog signals.
4.	Apply appropriate theoretical principles to characterize the behavior of Linear Time Invariant (LTI) Systems.
5.	Use the Laplace transform and the Z-transform to treat a class of signals and systems broader than what Fourier techniques can handle.
Outline Syllabus	
1.	**Introduction to Signals and Systems (2 h):** Classification of signals as continuous-time, discrete-time and digital. Theoretical building block signals such as the impulse and step functions. Introduction to systems and input-output relationships. Characterizing Linear Time- Invariant (LTI) systems. Overview of the analysis techniques applicable to each type of signal/system and their interrelationships.
2.	**Fourier Analysis (10 h):** Overview of Fourier analysis as the representation of signals with complex sinusoids. The Fourier series representation of periodic signals and the Fourier transform for the representation of non-periodic energy signals. Properties of the Fourier series and the Fourier transform. Theorems applicable in Fourier analysis.
3.	**Sampling and Reconstruction (6 h):** Frequency domain representation of sampling. The sampling theorem and aliasing. Reconstruction of a bandlimited signal from its samples. Discrete-time processing of continuous-time signals using discrete-time Fourier analysis techniques.
4.	**Linear Time Invariant (LTI) Systems (10 h):** Characteristics of LTI systems. Characterizing the input-output relationship of continuous- and discrete-time LTI systems in the time domain. The convolution theorem and its application to LTI systems. Characterizing LTI systems in the frequency domain. Discrete-time LTI systems.
5.	**Laplace and Z-transforms (14 h):** Shortcomings of Fourier analysis. Introduction to the Laplace and Z-transforms as generalizations of Fourier analysis techniques. Application of the Laplace and Z-transforms for continuous- and discrete-time signals and systems respectively. Properties of the Laplace and Z-transforms and related theorems. Applications in filtering and equalization. The region of convergence, poles and zeros of transfer functions. Introduction to computational structures for implementing discrete-time systems. Introduction to transient behavior and stability.

Module Code	EN1093	Module Title	Laboratory Practice I			
Credits	3.0	**Hours/Week**	**Lectures**	0	**Pre/Co-requisites**	EN1013 EN1054 EN1060
GPA/NGPA	GPA		**Lab/Assignments**	9		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Develop the ability to analyze, design, and simulate electronic circuits.
2.	Design, construct and take measurement of electronic circuits in order to compare experimental results with theoretical analysis.
3.	Observe the amplitude and frequency responses of common amplifiers and filters.
4.	Apply time domain and frequency domain analysis tools to simulate and analyse signals and LTI systems.
5.	Design, construct, test, and demonstrate a given project and present the work orally and as a written report in small groups.
Outline Syllabus	
1.	Orientation to the use of Laboratory Instruments.
2.	Construction of a simple Zener-regulated dc power supply.
3.	Build and take measurements on a simple BJT amplifier.
4.	Develop logic gates using DL, DTL, RTL and test logic gates using TTL and CMOS ICs.
5.	Construct combinational logic circuits: half adder, full adder, encoder, multiplexer.
6.	Observe communication channel characteristics and effects of noise.
7.	Simulate and study analog modulation schemes.
8.	Simulate and study digital modulation schemes.
9.	Construct and test an FM radio receiver.
10.	Design and build a Yagi antenna for VHF - TV reception.
11.	Simulate and observe the properties of continuous-time signals by applying Fourier techniques for their analysis and synthesis.
12.	Simulate and observe LTI systems such as impulse response, step response, convolution and frequency response.
13.	Sample analog signals and reconstruct them from samples.
14.	Analyze discrete-time systems – MATLAB.
15.	Group design project.

Module Code	EN1970	Module Title	Communication Skills			
Credits	1.0	Hours/Week	Lectures	1/2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Make a public speech confidently on a non-technical topic.
2.	Write effective non-technical documents.
3.	Communicate effectively in seeking employment.
Outline Syllabus	
1.	**Public Speaking Fundamentals:** Effective speech writing comprising an opening, a body and a conclusion, vocal variety and body language, effectively using visual aids, providing evidence.
2.	**Fundamentals of Writing:** Writing a synopsis, a critique, and an abstract.
3.	**Communications for Seeking Employment:** Writing a personal mission statement, curriculum vitae, facing an interview effectively.

Module Code	EN1070	Module Title	Electronic Product Design and Manufacture			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	NGPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify basic engineering design concepts.
2.	Use design tools for electronic product prototyping.
3.	Identify various manufacturing processes involved in electronic product manufacture.
4.	Identify issues related to manufacturing during the design stage.
5.	Apply the knowledge gained to a simple design project resulting in a working prototype

Outline Syllabus	
1.	**Design Principles (4 h):** Introduction to engineering design, life cycle of engineering products and processes, design processes and design tools, concurrent engineering, creativity and reasoning, analysis and synthesis, simulations, evaluation and decision making.
2.	**Basic Software tools needed for Electronic Design and Manufacture (4 h):** Electronic circuit design software, simulation software, solid modeling software and thermal analysis software..
3.	**Product Dissection (4 h):** Electronic product disassembly and identification of manufacturing processes.
4.	**PCB manufacturing (4 h):** Schematic design, layout design, design rules, photo-tool creation, drilling, plating, etching, solder masking.
5	**Component Mounting (4 h):** Through-hole component forming, component insertion, surface mounting.
6.	**Soldering Methods (4 h):** Hand soldering, wave soldering, reflow soldering.
7.	**Enclosures (4 h):** Injection moulding, metal forming, metal punching.
8.	**Design Assignment (30 h):** Group based design project covering following aspects. a) gathering of data and information from various sources as a preliminary to the design b) preparing a work plan and delegating duties c) working with others and to produce results by given deadlines and within given costs d) learning the basic procedures required for conceptual, preliminary and detailed designs e) learning the importance of the cost component in the manufacturing process f) learning the importance of considering the limitations of manufacturing processes during design g) preparing a report and making a presentation on the work done h) demonstrating the working of the prototype

Semester 3 Module Information

Module Code	EN2013	**Module Title**	Electronics II			
Credits	3.0	**Hours/Week**	**Lectures**	3	**Pre/Co-requisites**	-
GPA/NGPA	GPA		**Lab/Assignments**	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Design BJT and FET amplifiers.					
2.	Design of Op Amp circuits.					
3.	Use appropriate A/D and D/A converters for a given application.					
4.	Design a sequential digital circuit with not more than eight states.					
Outline Syllabus						
1.	**Transistors and their Applications (16 h):** Transistor bias consideration, β- uncertainty and temperature effects, AC load line, small signal mid-frequency analysis, high-frequency analysis.					
2.	**Op amps and their Applications (8 h):** Differential amplifiers, op amps, Inverting and non-inverting amplifiers, summing, differentiating and integrating op amp circuits, Schmitt triggers.					
3.	**A/D and D/A Converters (6 h):** Sample and hold devices, Types of A/D and D/A converters.					
4.	**Sequential Logic Circuit Design (12 h):** Introduction to flip-flops and latches, state diagrams, state reduction and assignment, excitation tables, circuit design, analysis of unused states.					

Module Code	EN2040	Module Title	Random Signals and Processes			
Credits	2.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN1060
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Discuss different ways in which probabilistic models are used in telecommunications theory and practice.
2.	Examine random variables in terms of their statistical characteristics.
3.	Manipulate bivariate random variables.
4.	Identify the defining parameters of random vectors and their usage.
5.	Examine random processes in terms of their statistical characteristics.
6.	Infer noise as a random process.

Outline Syllabus	
1.	**Introduction (2 h):** Review of deterministic signals and systems analysis. Differentiate random signals from deterministic signals. Review of basic probability concepts. Introduction to random variables and processes. Illustrative application of probability models in communications such as the binary symmetric channel.
2.	**Random Variables (6 h):** Definition of a random variable. Classification of random variables as continuous and discrete. Characterization of each type of random variable using the probability density/mass function, the cumulative distribution function, mean and variance. Functions of random variables. Transformation of random variables. Uniform, Binomial and Poisson random variables and examples of their application in communication systems. The Gaussian (normal) random variable, its characteristics and application in signal detection in noisy channels.
3.	**Bivariate Random Variables (4 h):** Joint and conditional distributions, correlation and independence. Transformation of bivariate random variables. The Rayleigh random variable and its application in wireless channel characterization. Characterization of jointly Gaussian random variables.
4.	**Random Vectors (4 h):** Extension of bivariate random variable analysis to random vectors (multivariate random variables), multivariate probability density functions, correlation and covariance matrices. Characteristics of the Gaussian random vector. Illustration of applications in multi-antenna systems
5.	**Random Processes (8 h):** Examples of real-life phenomena which can be modeled as random processes. Characterization of random processes, their classification as stationary, wide sense stationary and ergodic. Derivation of the power spectral density function of random processes. Multiple random processes and their interrelationships. Transmission of random processes through linear time invariant systems, and related spectra. Examples of processes in communications systems which are modeled as random processes.
6.	**Noise as a Random Process (4 h):** Representation of white noise, low-pass noise, and band-pass noise as random processes. Illustrative applications such as in performance analysis of communication systems, optimum filtering.

Module Code	EN2053	Module Title	Communication Systems and Networks			
Credits	3.0	Hours/Week	Lectures	3	Pre/Co-requisites	EN1054
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Review the different functions required in a communications network and how they are implemented in a layered architecture.
2.	Explain key functions and protocols of the physical layer, and describe their implementation in standards.
3.	Explain key functions and protocols of the data link layer, and describe their implementation in standards.
4.	Examine the wide variety of access networks available for subscribers of telecommunication services.
5.	Discuss telecommunications core network infrastructure and its role in forming an integrated telecommunications system.
6.	Select a suitable transmission medium and design an appropriate communication link for a given scenario.
Outline Syllabus	
1.	**Communications Networks (2 h):** Classification of networks according to range, topology, function etc. Layered structure of communication protocols and reference models, network elements and their roles.
2.	**The Physical Layer (8 h):** Functions of the physical layer including line encoding, synchronization, modulation, multiplexing and encryption. Illustrative examples of physical layer implementations from a variety of wired and wireless standards such as RS232, USB, FDDI, Ethernet, Bluetooth, WiFi, HDMI, FireWire.
3.	**The Data Link Layer (12 h):** Key design issues present in the data link layer. Flow control techniques and their analysis. Forward error control and automatic repeat request (ARQ) techniques and their analysis. Introduction to different types of error detection and error correction codes. The High Level Data Link (HDLC) protocol and its implementation in different networks. Medium access mechanisms in the data link layer such as Token-based, CSMA/CD, CSMA/CA and ALOHA. Examples of their implementation in different types of shared-medium networks such Ethernet (wired and wireless), token ring, satellite and terrestrial wireless networks. Introduction to the network layer
4.	**Access Networks (10 h):** The role of access networks. Systems view of copper, wireless (fixed and mobile, satellite) and fiber access networks. The PSTN, ADSL, wireless LANs and cellular networks as examples, highlighting the physical and data link layer components. Comparison of different access networks.
5.	**Core Networks (4 h):** The role of core networks and their functions. Physical media, architecture and elements of core network infrastructure. Introduction to high speed transmission and switching techniques such as SONET, DWDM, ATM, IP.
6.	**Communication Link Design (4 h):** Review of radio wave propagation in the microwave region and signal propagation over optical fibers. Design issues in terrestrial/satellite microwave and optical fiber communications. Simple power budgets for optical and microwave links
7.	**Other Communications Systems (2 h):** Introduction to RADAR, navigation and broadcasting.

Module Code	EN2080	Module Title	Fundamentals of Computer Organisation and Design			
Credits	3.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain functional blocks of a computer system.
2.	Discuss performance metrics of a computer system.
3.	Explain basic processor architectures.
4.	Design a 8 bit RISC processor.
5.	Design a memory hierarchy for a computer system.
6.	Explain interfacing with memory and I/O devices and the need for bus based systems.
7.	Discuss the operating system as a resource manager.
Outline Syllabus	
1.	**Introduction (3 h):** Computer as a data processing system, functional blocks of a computer system.
2.	**Performance Metrics of a Computer System (3 h):** Throughput, speed, response time, Amdhal law, quantitative principles of computer design.
3.	**Processor Architecture (8 h**): Von-Neumann model, instruction set architecture, evolution of architecture –RISC, VLIW, EPIC**.**
4.	**Processor Design (10 h):** Micro-architectures (hardwired and microprogramming).
5.	**Memory (8 h):** Principles of DRAM, SRAM and their construction, organization of memory, principle of cache memory and its design considerations, specification of memory, interfacing and performance issues.
6.	**Interfacing (4 h):** Low and high speed peripherals, internal and external bus architectures: AMBA, Wishbone, USB, and PCI.
7.	**Operating Systems (6 h):** Processes and threads, memory management, virtual memory, scheduling, concurrency.

Module Code	EN2090	Module Title	Laboratory Practice II			
Credits	3.0	Hours/Week	Lectures	0	~~Pre~~/Co-requisites	EN2013 EN2053 EN2080
GPA/NGPA	GPA		Lab/Assignments	9		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Simulate and construct combinational and sequential logic circuits.
2.	Develop digital circuit design using programmable ICs.
3.	Construct building blocks of a computer.
4.	Develop an understanding of programming in assembly language.
5.	Design and build simple communication networks.
6.	Design, construct, test, demonstrate a given project and present the work orally and as a written report, in small groups.
Outline Syllabus	
1.	Build and take measurements on op amp circuits in order to identify applications of op-amps.
2.	Construction of circuits to control AC power and to compare experimental values with theoretical analysis.
3.	Design a microcontroller based simple digital circuit using the PC based PIC simulator and implement the circuit.
4.	Design and implement simple digital circuits on FPGA.
5.	Use a 4-bit ALU to perform different binary arithmetic and logic operations.
6.	Identify and construct memory cells: SRAM and DRAM.
7.	Implement basic programming constructs like conditional statements, control loops (for, while) in assembly language in x86 and micro-controller environments.
8.	Develop and study physical and data link layer communications protocols.
9.	Develop a terrestrial microwave link design.
10.	Group design project.

Module Code	EN2532	Module Title	Robot Design and Competition			
Credits	2.0	Hours/Week	Lectures	1	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Design a robot to perform a simple task.
2.	Identify what sensors and actuators are most appropriate for a simple robot.
3.	Build and tune an actual autonomous mobile robot and its control algorithm.
Outline Syllabus	
1.	**Introduction to Autonomous Mobile Robots (4 h):** Sense-think-act cycle of autonomous mobile robots, basic mobile platforms, robot system design, power and control issues of mobile robots.
2.	**Sensors and Actuators Motors (10 h):** Operating principle and control techniques of DC, stepper, and servo motors, interfacing motors to microcontroller boards. Operating principle of IR, switch, sonar, and compass sensors, microcontroller interface for these sensors.
3.	**Building Robots:** Design a fully autonomous robot for a given competition task, robot task planning, working with a microcontroller based robot programming board, sensors and actuator integration, programming control algorithms, tuning controller gains, troubleshooting sensors, motors and control algorithms.

Semester 4 Module Information

Module Code	EN2110	Module Title	Electronics III			
Credits	4.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Analyze first order filter circuits.					
2.	Select a power amplifier for a given application.					
3.	Explain characteristics of power electronic devices.					
4.	Analyze timing related issues in digital circuits.					
5.	Design and implement digital circuits using programmable logic devices.					
Outline Syllabus						
1.	**First Order Filter Design (6 h):** Passive and active filters, frequency analysis, poles, zeros, Bode plots.					
2.	**Power Amplifiers (6 h):** Classes of amplifiers, characteristics of amplifiers.					
3.	**Power Electronic Devices (10 h):** Properties and characteristics of power electronic devices, power electronic circuits, switching circuits.					
4.	**Timing Analysis of Digital Circuit (4 h):** Gate delays, propagation delays, hazards, operating frequency, stability, case study simple RS232 communication link.					
5.	**Programmable Logic Devices (6 h):** ROM, PALs and PLAs, simulation and synthesis of digital circuits using FPGAs and HDL.					
6.	**Design Projects Based on Amplifiers, Power Electronic Devices and Programmable Logic Devices (10 h)**					

Module Code	EN2073	Module Title	Analog and Digital Communications			
Credits	4.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Analyze different analog modulation schemes theoretically in order to discriminate between them.
2.	Explain the reasons for the use of different analog modulation schemes in different applications.
3.	Analyze the representation of analog signals in digital form.
4.	Identify and compare the distinctive features and advantages of different types of PCM techniques in order to select the most appropriate technique for a given scenario.
5.	Apply mathematical and geometrical representation of signals for baseband communication systems in order to design and analyze signal sets.
Outline Syllabus	
1.	**Amplitude Modulation (6 h):** Baseband vs. bandpass communications, review of amplitude modulation: double sideband and double-sideband suppressed carrier, asymmetric sideband signals: single sideband and vestigial sideband. Performance analysis in noise. Carrier acquisition: phase locked loops. Receivers for amplitude modulation schemes.
2.	**Angle Modulation (8 h):** Review of phase and frequency modulation, and spectra. Generation and demodulation of FM signals, pre-emphasis and de-emphasis in angle-modulated systems, FM receivers, and performance analysis in noise.
3.	**Applications of Analog Modulation (6 h):** Radio and TV broadcasting, AM and FM broadcast technical standards. Applications in navigation.
4.	**Digitization of Analog Signals (10 h):** Sampling theorem: Nyquist rate, ideal sampling and reconstruction, practical sampling and reconstruction, practical issues, pulse amplitude modulation (PAM),quantization, pulse code modulation (PCM): sampling, non-uniform quantization, and encoding, bandwidth and noise considerations in PCM, differential PCM, delta modulation and linear predictive coding.
5.	**Baseband Digital Transmission (12 h):** PAM signals and their power spectra, line codes and their spectra, geometric space representation of signals and noise, and performance analysis in AWGN channels: optimum detectors for binary polar signaling and general binary signaling, and space analysis of optimum detection.

Module Code	EN2083	Module Title	Electromagnetics			
Credits	4.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain the concepts of static electric and magnetic fields within and at the boundaries of different media.
2.	Use appropriate techniques to calculate the capacitance and inductance for different transmission lines and waveguide geometries.
3.	Apply Maxwell's equations to electromagnetic wave propagation scenarios in dielectric media, conducting media and waveguides.
4.	Analyze simple antenna structures.

Outline Syllabus	
1.	**Static Electric and Magnetic Fields (8 h):** Poisson's and Laplace's equations and their applications. Integral and differential forms of Gauss's and Ampere's law applied to static electric and magnetic fields. Capacitance and inductance of twin lines and coaxial lines, boundary conditions, effect of earth on transmission line properties.
2.	**Dynamic Fields (4 h):** Faraday's Law, Maxwell's equations and their uses in communications.
3.	**Plane Wave Propagation (8 h):** Concepts of electromagnetic wave propagation, uniform plane wave propagation in a dielectric and conducting media, intrinsic impedance of a medium, phase velocity, group velocity, propagation constant, Poynting's theorem, skin depth, boundary conditions, reflection and transmission coefficients of electromagnetic waves at normal incidence, oblique incidence , Brewster angle, critical angle, polarization.
4.	**Transmission Lines (6 h):** Distributed component model, characteristic impedance, propagation characteristics, reflection, voltage standing waves, Smith chart and impedance matching.
5.	**Guided Wave Propagation (6 h):** Introduction to metal waveguides, wave propagation through a rectangular and circular metal waveguide, TE and TM modes, power flow through a waveguide, cavity resonators.
6.	**Antenna Basics (4 h):** Isotropic and anisotropic radiators, antenna radiation patterns, directivity, gain, antenna aperture, retarded potentials, radiation, near field and far field, types of antennas.
7.	**Wire Antennas (6 h):** Dipoles, monopoles, antenna arrays.

Module Code	EN2510	Module Title	Digital Signal Processing			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN1060
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Design a filter for given specifications.
2.	Discuss the Fourier transform in discrete time and discrete frequency domains.
3.	Analyze a given filter for performance and stability.
4.	Discuss the impact of finite precision arithmetic.
5.	Discuss the need for adaptive filtering.
6.	Implement digital filters in hardware.

Outline Syllabus	
1.	**Discrete-Time Signals and Systems (4 h):** Review discrete time signals and systems Representation of discrete-time signals and systems, linear time invariant systems.
2.	**Filter Design (12 h):** Specifications, design approaches: Finite Impulse Response and Infinite Impulse Response filters.
3.	**Realization of Filters (6 h):** Structures for discrete-time systems.
4.	**Fourier Transform in Discrete Domains (6 h):** Discrete-time Fourier transform, discrete Fourier transform, fast Fourier transform.
5.	**Stability and Performance of Filters (4 h):** Frequency and Z-domain analysis of filters
6.	**Finite Precision Arithmetic (3 h):** Design decisions, impact on filter stability and performance.
7.	**Introduction to Adaptive Filtering (4 h):** Classification and basic principles.
8.	**Platforms for Hardware Implementation of Digital Filters (3 h):** Dedicated DSP hardware, DSP Microcontrollers, FPGA.

Module Code	EN2550	Module Title	Fundamentals of Image Processing and Machine Vision			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Apply image processing algorithms for image enhancement.
2.	Apply machine vision algorithms for detection and recognition.
3.	Design machine vision solutions for common industry problems.
Outline Syllabus	
1.	**Describe the Digital Representation of Images (2 h):** Representation of a grayscale digital image as a 2-D array of numbers, representation to color images, concepts of resolution and DPI, interpolation algorithms for image scaling.
2.	**Image Processing (6 h):** Point and neighborhood operations for image enhancement, 2-D Fourier techniques frequency-domain algorithms to replicate spatial domain operations, morphological operations.
3.	**Machine Vision (8 h):** Cameras and fundamental multiple view geometry, basic segmentation algorithms, simple classifiers, detection and recognition.
4.	**Industry Applications of Image Processing (4 h):** Photo processing for printing, medical image processing.
5.	**Industry Application of Machine Vision (4 h):** Camera as a measurement device, vision for automation.
6.	**Case Studies of Image Processing and Vision in Practice (4 h)**

Module Code	EN2560	Module Title	Internet of Things Design and Competition			
Credits	2.0	Hours/Week	Lectures	1	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain the concept of IoT and the system view.
2.	Analyze the characteristics of IoT devices.
3.	Develop specifications of an IoT device.
4.	Design and implementation of an IoT based system.
5.	Evaluation of performance of IoT devices .
Outline Syllabus	
1.	**IoT (2 h):** Concept of Internet-connected devices and the system, its applications.
2.	**Device Characteristics (2 h):** Sensor types, ultra-low power requirements for processors and communication links.
3.	**IoT Device Specification (2 h):** Mapping of functional requirements to specifications, identification of sensors.
4.	**Design and Implementation of IoT System (4 h):** Choosing of appropriate platform, energy-aware algorithms.
5.	**Evaluation of Performance of an IoT System (2 h):** Robustness (predictability and consistency of response), response time, power consumption.

Semester 5 Module Information

Module Code	EN3023	**Module Title**	Electronic Design Realization				
Credits	3.0	**Hours/Week**	**Lectures**	2	**Pre/Co-requisites**	EN1070	
GPA/NGPA	GPA		**Lab/Assignments**	3			
Learning Outcomes							
At the end of this module the student will be able to:							
1.	Identify a suitable design model for a given problem.						
2.	Design testable PCBs complying to industry standards.						
3.	Design product enclosures complying to industry standards .						
4.	Prepare proper documentation for electronic design .						
5.	Apply the knowledge gained to a commercial design project resulting in a working prototype.						
Outline Syllabus							
1.	**Design Models (2 h):** User centered design, design driven innovation.						
2.	**User-centered Design (4 h):** Need analysis, conceptual design, detail design, design iterations.						
3.	**Design-driven Innovation (2 h):** Existing meaning, quiescent meaning, technology epiphany, design interpreters.						
4.	**Circuit Design and Prototyping (6 h):** Top-Down/Bottom-Up approaches, schematic design, HDL design, simulation and verification, PCB prototyping .						
5.	**Testing (6 h):** Test coverage, boundary scanning, test vector generation, prototype testing and design verification, product testing and quality assurance.						
6.	**Enclosure Design (4 h):** Solid modeling and visualization, rapid prototyping, mould design, tool design.						
7.	**Documentation (4 h):** User manuals, maintenance manuals, QC manuals, design manuals.						
8.	**Design Assignment:** Group based commercial design project covering the following aspects: a) User need surveys/Quiescent meaning b) PCBs meeting industry standards/norms c) Enclosures meeting industry standards/norms d) Design documentation						

Module Code	EN3030	Module Title	Circuits and Systems Design			
Credits	4.0	Hours/Week	Lectures	3	Pre/Co-requisites	EN2110
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain the effects of negative feedback on the performance of electronic circuits.
2.	Design and analyze analog circuits, such as second order filters, oscillators, phase locked loops, linear power supplies.
3.	Analyze effects of noise in electronic circuits.
4.	Design and implement sequential systems using RTL based approach.
5.	Design and implement 8 bit non-pipelined processor.
6.	Analysis of timing related matters in digital systems.
Outline Syllabus	
1.	**Feedback (6 h):** General feedback structure, negative feedback, properties of feedback circuits, loop gain and stability.
2.	**Analog Filter Design (4 h):** Second order passive and active filter design, Butterworth and Chebyshev approximations.
3.	**Oscillators (4 h):** Astable, mono-stable, and bi-stable multi-vibrators, Schmitt triggers.
4.	**Phase Locked Loops (2 h):** Operating principles, PLL types, and frequency synthesis.
5.	**Linear Power Supplies (4 h):** Voltage regulators, and protection circuits.
6.	**Noise Analysis (4 h):** S/N, Noise figure, noise temperature, low noise amplifiers (LNA).
7.	**RTL Design, Implementation and Verification (8 h):** Sequential system design using RTL based approach and its HDL implementation, introduction to functional and logic verification.
8.	**Processor Design and Implementation (8 h):** Instruction set architecture, RISC architecture, data path and controllers, cache memory design, memory interfacing, RAM, ROM, EPROM, SRAM, DRAM, memory cells.
9.	**Timing Analysis (2 h):** Determination of operating speed of digital systems (longest delay path), different delay types, clock synchronization issues.

Module Code	EN3053	Module Title	Digital Communications I			
Credits	4.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Analyze different digital modulation techniques theoretically in order to discriminate between them.
2.	Design optimum receivers for linear modulation schemes in AWGN channels.
3.	Design signals for communication over bandwidth constrained channels.
4.	Examine signal distortions introduced by the channel and design a linear equalizer for a given situation.
5.	Compare and contrast broadband communications technologies with conventional modulation schemes in order to appreciate their advantages and applications.
Outline Syllabus	
1.	**Digital Carrier Modulation Techniques (12 h):** Bandpass signals and systems: complex envelope representation and signal-space representation, linear digital modulation techniques: ASK, PSK, and QAM. OQPSK and π/4-QPSK, nonlinear modulation techniques: FSK, minimum shift keying, and GMSK, power spectra and spectral efficiencies, coherent receivers, and digital subscriber lines and modems.
2.	**Receiver Design for AWGN Channel and Performance (12 h):** Optimal detection of signals in noise: detection signal space, correlation detector, matched-filter detector, maximum a posteriori and maximum likelihood detectors, performance of optimum receivers for linear modulation schemes: optimal decision regions and error probability.
3.	**Signal Design for Bandwidth-Constrained Channels (12 h):** Characterization of band-limited channels, signal design for band-limited channels: band-limited signals for no ISI, Nyquist criterion, band-limited signals with controlled ISI-partial response signals, and detection of duobinary signaling and differential encoding, channel equalization: need for equalization, and ZF and MMSE equalizers, eye diagrams.
4.	**Introduction to Broadband Technologies (6 h):** Principles of multicarrier modulation and spread spectrum communications, characteristics, advantages and applications.

Module Code	EN3143	Module Title	Electronic Control Systems			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify historical apparatus where negative feedback mechanism is used.
2.	Analyze and model physical systems using laws of nature.
3.	Design a feedback control system and analyze its performance and stability.
4.	Implement analog and digital controllers.

Outline Syllabus	
1.	**History of Control Engineering (2 h):** Historical apparatus based on negative feedback mechanism (water clock, flyball governor).
2.	**System Modeling (10 h)**: Modeling mechanical systems using Newton's laws, and electrical systems using Kirchoff's laws, system model ODE, transformation to Laplace domain, transfer function, second order systems (damping ratio and natural undamped frequency): rise time, peak time, peak overshoot, settling time.
3.	**Feedback Controller Design (12 h):** Single feedback gain controller, root locus design, pole location by gain tuning, Bode (gain and phase) design, lead, lag and notch filter design, pole-zero cancellation, stability analysis, PID controller design. Controller simulation using Matlab/Simulink, servo controller design for a given specification.
4.	**Controller Implementation (4 h)**: Op-Amp implementation of analog controller, discretization of controllers for digital controller design, digital controller implementation using microcontrollers.

Industrial Training Module Information

Module Code	EN3992	**Module Title**	Industrial Training			
Credits	6.0	**Hours/Week**	**Lectures**	-	**Pre/Co-requisites**	-
GPA/NGPA	NGPA		**Lab/Assignments**	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Appreciate the differences between academic and industrial environments.					
2.	Value the training institutions relevance to engineering and engineering management.					
3.	Relate the knowledge gained via training to the project which will be assigned and bring it to completion.					
4.	Adhere to engineering ethics, industrial safety standards and processes.					
5.	Present the findings in a training report.					
Outline Syllabus						
1.	**Induction:** This is an initial period to help the student in the transition from academic to industrial life. The students should meet his/her mentor to discuss the contents and the objectives of training. He/She should also receive information about the training organization, its products or services and the terms and conditions of employment.					
2.	**Practical Skills:** During this period the student should receive instructions in the practical skills essential for his/her future employment. It should also include an appreciation of the work of others in converting an engineering design into a final product (if appropriate).					
3.	**General Engineering Training:** In a large organization this should include an introduction to the work done in a number of departments. Under these circumstances, the student may eventually be working as a member of a team in the organization. The student should be made aware of the management and administration sectors of the organization.					
4.	**Directed Objective Training:** The major part of the training should have directed application to the activity which the student intends to follow after the training program (activities should be relevant to the major in which the student will be graduating in). At this stage the student should be encouraged to work on a real project and be given increasing responsibility for independent work to establish interest and confidence in his/her work. *Most of the training time will cover design and development, documentation and data preparation, and commissioning. The student should also have a thorough understanding of the operations of the training place in the electronics and telecommunication engineering context.*					

Semester 6 Module Information

Module Code	EN3110	Module Title	Electronic Devices			
Credits	4.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Discuss the basics of quantum mechanics in order to characterize electronic devices.
2.	Explain the principles underlying the behavior of electronic devices.
3.	Explain the principle of operation of lasers and applications of lasers.
Outline Syllabus	
1.	**Quantum Mechanics (20 h):** Wave-particle duality of light and matter, Schrödinger wave equation: Band theory of solids, E-k diagram, Fermi-Dirac statistics and Fermi Level.
2.	**Electronic Devices (12 h):** Conduction in metals and semiconductors. Conduction in p-n junction devices, diffusion and junction capacitance of a p-n junction, diodes characteristics, bipolar junction transistors, field effect transistors, microwave devices.
3.	**Lasers and Optical Resonators (10 h):** Energy levels and stimulated emission of radiation.

Module Code	EN3223	Module Title	Electronic Manufacturing Systems			
Credits	3.0	Hours/Week	Lectures	3	Pre/Co-requisites	EN1070 EN3023
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Design an electronic product manufacturing process.
2.	Carry out production planning and production control.
3.	Carry out raw material control.
4.	Apply productivity improvement techniques and manufacturing information management techniques.

Outline Syllabus	
1.	**Electronic Product Manufacturing Process (8 h)**: Manufacturing process design and engineering, translation of product design information to manufacturing information.
2.	**Production Processes (6 h)**: Production planning, scheduling, production strategies: make-to-order, make-to-stock.
3.	**Material Control System (4 h)**: Incoming raw material control, material ordering and stocking, Cumban system.
4.	**Product Fabrication, Assembly, Testing, Repair and Quality Control (6 h)**
5.	**Productivity Improvement, Manufacturing Information Management (4 h)**

Module Code	EN3240	Module Title	Embedded Systems Engineering			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Discuss the performance requirements of an embedded system in terms of power consumption, resource utilization and real time response.
2.	Explain the functionality of modules and their interconnections of a typical embedded system in consumer and industrial domains.
3.	Explain the performance requirements expected from the software layer in an embedded system.
4.	Evaluate different processors and microcontrollers available for embedded systems.
5.	Design an embedded system to meet a given specification.
Outline Syllabus	
1.	**System Specifications & Constraints (4 h):** Functionality, Predictability, Power Consumption, Size, Real Time Response, Safety, Price, Time to Market.
2.	**Embedded Systems Architecture, Development Flow and Design Methodologies (6 h)**
3.	**Embedded Hardware (6 h)**: Soft and hard processors, microcontrollers and peripherals, programmable system on chip (PSOCs) with custom and 3rd party IP cores.
4.	**Embedded Software(4 h)**: Real time operating systems (RTOS), device drivers and resource aware programming.
5.	**Hardware-Software Co-Design, Debugging and Testing (4 h)**
6.	**Interfacing Memory and Peripherals (2 h)**: Buses, interrupts, timers, analog inputs.
7	**Power Management, System Robustness, Optimizations and Security Concerns (2 h)**

Module Code	EN3250	Module Title	Internet of Things			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Discuss the concept of IoT and Smart X.
2.	Discuss the characteristics of IoT devices.
3.	Evaluate the technologies available for IoT.
4.	Evaluate the performance of IoT devices.
5.	Discuss security concerns of IoT.
6.	Discuss the user expectation and social impact of IoT devices.

Outline Syllabus	
1.	**Internet of Things (4 h):** The concept of Internet connected devices and its applications, Smart X, machine to machine (M2M) technologies, collaboration between devices in a distributed systems, micro and Nano scale devices, cloud concept and devices for the edge of the cloud.
2.	**Device Characteristics (4 h):** Always on and always aware, adaptability, autonomous behavior, dependability, controllability, self-sustainability (ultra-low power consumption).
3.	**Technologies for IoT (10 h):** Sensors, low power and ultra-low power processors, ultra low power communication technologies, energy aware algorithms, energy harvesting.
4.	**Performance of IoT Device (4 h):** Response time, predictability and consistency of responses, self-sustainability (ultra-low power consumption and energy harvesting).
5.	**Security Concerns of IoT (2 h):** Collection of data and the threat of data leakages (privacy issues), security concerns linked to remote controllability of devices.
6.	**Analysis of User Expectations and Social Impact of IoT Devices (4 h):** Examples such as IoT devices used as a personal protection device and its social impacts.

Module Code	EN3370	Module Title	Traffic Engineering			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe the different queuing theories related to telecommunication systems and their impact on modeling of telecom networks.
2.	Apply appropriate queuing models to analyze a real world application.
3.	Assess the need for traffic engineering in core networks.
4.	Model network traffic.
5.	Apply the knowledge of traffic theory to simulate real networks.
6.	Analyze the performance of scheduling algorithms used in networks.
Outline Syllabus	
1.	**Review of Random Processes (4 h):** Definition of random processes, statistics of random processes, stationarity and ergodicity, Markov chains and Markov processes.
2.	**Queuing Theory (6 h):** Poisson processes, Little's formula, birth and death processes, M/M/x/x queues, Erlang formulas, dimensioning of loss and delay systems, performance evaluations.
3.	**Network Traffic (4 h):** Flow traffic models, continuous and discrete time modeling, self-similar traffics, Pareto distribution.
4.	**Fluid Flow Analysis (4 h):** On-off sources, infinite and finite buffers, leaky bucket, equivalent bandwidth, long range dependent (LRD) traffic.
5.	**Traffic Simulation (4 h):** Random number generation, discrete event simulation, time driven simulation, event driven simulation.
6.	**Traffic Measurement (2 h):** Common traffic parameters, measurements recommended by ITUT.
7.	**Application Examples (4 h):** Traffic and mobility modelling in communication networks, switches and routers.

Module Code	EN3532	Module Title	Electronic Instrumentation			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN1013
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe characteristics of electronic instruments.
2.	Explain the operational principles of electronic measuring instruments.
3.	Analyze measurement errors and improve the accuracy of measurements.
4.	Design a simple measuring instrument.

Outline Syllabus	
1.	**General Measurement Theory (2 h):** The foundations of electronic measurement theory, measurement errors and error reduction techniques, factors influencing measurement errors, signals and noise in measurement systems.
2.	**Generalized Performance Characteristics of Instruments (2 h):** Static characteristics, dynamic characteristics.
3.	**Fundamental Operational Principles of Instruments (8 h):** Voltmeters and ammeters (analog and digital), signal sources and function generators, oscilloscopes and their measurements, electronic counters, power supplies, spectrum and network analyzers, logic analyzers.
4.	**Transducers and Bridges (4 h):** Types of transducers and AC and DC bridges.
5.	**Instrumentation Circuits (4 h):** Signal conditioning, instrumentation amplifiers, data acquisition and transmission circuits.
6.	**Instrument Usage (4 h):** Probes and other attachments, grounding and shielding design, choosing instruments for a given instrumentation environment.
7.	**Control in Electronic Instruments (4 h):** Use of embedded control in instrumentation.

Module Code	EN3210	Module Title	Self Initiated Innovation			
Credits	3.0	Hours/Week	Lectures	-	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Generate self motivation and enthusiasm about problem analysis and solution.					
2.	Discover creative ways of solving an identified problem.					
3.	Apply a multidisciplinary approach as appropriate towards solving an identified problem.					
4.	Demonstrate correct scientific/engineering methodology in problem solving.					
5.	Present a solution orally and in writing.					
Outline Syllabus						
1.	**Problem Identification**: Identify an existing problem in the industry or in the society.					
2.	**Domain Knowledge:** Gather domain knowledge related to the identified problem and collaborate with resource persons having domain knowledge.					
3.	**Problem Solution:** Adopt the correct problem solving approach towards solving an identified problem.					
4.	**Case Study:** Study and critically evaluate existing solutions to identified problems and propose improvements.					
5.	**Technical Presentation:** Present a solution to an identified problem in a professional manner. Prepare a technical report describing the solution.					

Module Code	EN3900	Module Title	Seminar			
Credits	2.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	NGPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Demonstrate theoretical knowledge, analytical skills, as well as methodological, research design and problem-solving skills applied to novel problems of a multidisciplinary nature.
2.	Demonstrate skills in identification of the key issues and the ability to formulate a solution based on the interests of the different stakeholders.
3.	Give constructive criticism and accept feedback as part of the process of peer review.
4.	Demonstrate good project management, teamwork and communication skills in oral and graphical presentation.
Outline Syllabus	
1.	Technical and within Industry, exposing novel technological advances.
2.	Problem from outside of the industry (e.g., medicine and biology) requiring a multidisciplinary solution involving electronics and telecommunications.
3.	Exposing students to new ways of thinking leading to creativity and innovation.
4.	Exposing students to the marketing and business development aspect of industry.
5.	The technological innovations and their implications in health, culture and society (e.g., Smart apps leads to dumb users- A case study).
6.	The legal, ethical and safety implications of product development.
7.	The use of Appropriate sustainable solutions for the developing world (e.g., Prosthetics in rehabilitation).
8.	Student Presentations - 3 per week (40 min/presentation) –> 7 weeks to cover 20 presentations –> 20 x 5 = 100 students.

Semester 7 Module Information

Module Code	EN4202	Module Title	Project			
Credits	10.0	Hours/Week	Lectures	-	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Identify a real-world problem of sufficient complexity that can be solved using the technologies learnt during the undergraduate career within a given time frame.					
2.	Appreciate the need for group work in solving real-world problems and the role of the individual.					
3.	Demonstrate the skills required for writing a project proposal and associated business plan for the problem identified.					
4.	Defend the proposal drafted for solving a real-world problem.					
5.	Apply the knowledge gained to determine alternative approaches to solving the problem.					
6.	Analyze different approaches to solve the identified problem.					
7.	Evaluate the different approaches to find the most suitable one.					
8.	Design and develop the solution using the selected approach.					
9.	Evaluate the effectiveness of the solution.					
10.	Justify the methods adopted in the solution.					
11.	Compile a comprehensive document detailing all aspects related to the project.					
Outline Syllabus						
1.	**Investigation Stage:** The student should be capable of independently referring to books, papers, academic literature and electronic resources to justify their choice of project. Conduct a literature survey in order to academically support any claims, technologies and methods used in your project. This phase should also be used to determine if there are other methods that have been used to address the same or similar implementation aspects of your project. As a consequence of this activity, the student should now have a number of sources of information upon which to base the work that is to follow. Identifying or estimating the hardware and software components required for the successful implementation of the proposed project is also carried out within the scope of this phase.					
2.	**Implementation Stage:** Once the preliminary investigation is carried out and a project of appropriate complexity is chosen, the next stage is to design and implement the prototype. Identifying the proper approach of implementation is also key to completing the project successfully. Use design software, simulation to support your design strategies. The implementation phase includes construction and testing of the prototype. A major portion of the time should be spent with this phase. At the implementation stage, the student is allowed to alter or modify the methodologies proposed in the previous phase depending on any new information available at this stage.					
3.	**Presentation Phase:** Placing the work in context and presenting it effectively is also an important part of the project. Effective presentation of the project material and a well-structured report is expected for the satisfactory completion of the final year project. The documentation and knowledge preservation includes a presentation, report, DVD with structured information as well as a viva.					

Module Code	EN4820	Module Title	Ethics and Legal Fundamentals			
Credits	1.0	Hours/Week	Lectures	1	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify the distinction between law and ethics.
2.	Assess a situation in a professional or academic environment from ethical and legal perspectives.
3.	Investigate the safety of a product from ethical and legal standpoints.
Outline Syllabus	
1.	**Introduction (2 h):** Social motivation for law and ethics, basic definition of law, morality, conscience and ethics.
2.	**Legal Fundamentals (2h):** Types of law, sources of law, interpretation of laws, natural justice and due process of the law, legal system of Sri Lanka, evidence, relevant laws in engineering (industrial relations, commercial law, contract law, intellectual property laws etc.), regulations, legal remedies, contempt of court, jurisprudence.
3.	**Ethics (2 h):** Types of ethics based upon formulation and application, ethics in professional and engineering environments, remedies for misconduct.
4.	**Safety Engineering (2 h):** Ethical and legal background, guidelines for safety, safety standards: regulations, compliance and hazard reporting, case studies (e.g. Ford Pinto case, Therac-25 case, Airline Cargo Door cases, etc.).
5.	**Research and Academic Ethics (2 h):** Misconduct during research: fraud, fabrication and plagiarism, informed consent, ethical standards during experimentation, teaching ethics and misconduct.
6.	**Supplementary Work (6 h):** Time to be utilized for possible guest lectures, field visits and discussion forums etc.

Module Code	EN4932	Module Title	Technical and Scientific Writing			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	NGPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify key characteristics of an effective technical document.
2.	Develop an appropriate structure for a technical document.
3.	Convey information effectively using proper language, writing style and illustrations.
4.	Carry out and present a literature review as required in a technical document.
5.	Use appropriate tools to create technical documents in a professional manner.

Outline Syllabus	
1.	**Introduction (1/2 h):** What is a technical document? Different types of technical documents. Characteristics of an effective technical document. The importance of recognizing the purpose of a technical document and the target audience. The process of preparing a technical document from planning to reviewing.
2.	**Structuring a Document (1 1/2 h):** General structure of a document. Guidelines for creating chapters, sections and subsections. Guidelines on developing specific chapters/ sections such as the abstract, introduction and the conclusion.
3.	**Language and Illustrations (1 h):** Constructing paragraphs, sentences. Using words in an appropriate manner, punctuation, mechanics. Using illustrations, tables etc. to convey information succinctly.
4.	**Literature Review and Referencing (2 h):** What is a literature review? Guidelines on carrying out a critical literature review and presenting the findings in a technical document. Definition of plagiarism and how to avoid it. Techniques for citing references, cross references, bibliography. Basic structure and formats of accepted referencing styles. Tools for managing bibliographies.
5.	**Tools for Documentation (2 h):** Use of several types of document preparation software such as Microsoft Word, Latex. Preparing and using templates for document creation.
6.	**Hands-on exercises:** a. Create a one-page document with a specific purpose for a specific audience b. Case study of a published technical article giving due consideration to its structure, writing style and overall effectiveness

Module Code	EN4063	Module Title	Digital IC Design			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain the digital IC design concepts.
2.	Recognize the technical challenges in digital IC design.
3.	Demonstrate the proficiency in VLSI design tools widely used in industry.
4.	Design and analyze the digital VLSI circuits at various design stages from functional design, logic design, circuit design, to physical design.

Outline Syllabus	
1.	**Digital Design Concepts (8 h):** Introduction to digital IC design, Digital design basics, RTL to netlist mapping, synthesis, high fan-out synthesis, clock tree synthesis.
2.	**Design for Test (4 h):** Define test modes, DFT insertion techniques.
3.	**Backend Design (6 h):** Floor plan, place and route, layout verification, IO design.
4.	**IP Development (4 h):** IP design flow, IO definition, test methodologies, characterization of IPs.
5.	**RTL2GDS Flow (6 h):** Familiarize with tools required for synthesis, place and route, timing analysis, and layout verification, design related problems and fixes.

Module Code	EN4213	Module Title	Power Electronics			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe the fundamental principles of different power electronic devices.
2.	Identify different applications in power electronics.
3.	Design various power electronic devices and circuits.
4.	Analyze power electronic circuits with the knowledge of power electronic devices and controllers.
Outline Syllabus	
1.	**Fundamentals of Power Electronics (2 h):** Introduction to power electronics, fundamentals of power electronics, devices and considerations.
2.	**Thermal Management of Power Devices (2 h):** Thermal management, heat sink calculation and power devices selection on thermal aspects.
3.	**Drive and Protection Circuits (4 h):** Drive circuits of power semiconductor devices, high side drivers and operation, protection circuits and measures, snubber circuits, over voltage and over current protection, EMI aspects.
4.	**DC/DC Converters (4 h):** Design of buck, boost and buck-boost converters, characteristics and practical aspects.
5.	**Inverters (4 h):** Voltage source and current source inverters, PWM, hysteresis and resonance pulse inverters, applications and control methods.
6.	**Advanced Power Supplies (8 h):** Switching regulators, switch mode power supplies, uninterrupted power supplies.
7.	**Motor Controlling (2 h):** AC, DC and BLDC motor controlling methods and design.

Module Code	EN3223	Module Title	Digital Communications II			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Select an appropriate source coding technique for a given application.
2.	Explain the underlined principles of optimal quantization of sampled analog signals.
3.	Design a lossless source code for a given discrete memory-less source to improve efficiency of transmission.
4.	Perform encoding and decoding operations pertaining to block and convolutional codes.
5.	Apply error control coding for the improvement of reliability of digital communication systems.
6.	Explain the basic concepts of data encryption and decryption, and different ways of using them in securing communication systems.

Outline Syllabus	
1.	**Source Coding (10 h):** Introduction to information theory, review of information measures: entropy, relative entropy, mutual information, and measures for continuous random variables. Lossless coding for discrete memoryless sources: Kraft inequality, Huffman coding, Shannon Fano-Elias coding, arithmetic coding, run-length coding, and Lempel-Ziv coding. Coding for analog sources: optimum quantization: rate distortion theory, scalar and vector quantization, review of predictive coding, transform coding, and examples of source coding: audio compression and video compression.
2.	**Channel Coding (10 h):** Introduction to error control coding. Linear block codes: matrix representation of block codes: generator and parity check matrices, cyclic codes, error detection and correction capabilities, hard decision decoding: syndrome decoding, and examples of common linear block codes, convolutional codes: convolutional encoding, state transition diagram and trellis diagram, minimum free distance, maximum likelihood decoding: hard decision and soft-decision decoding, and the Viterbi algorithm, and introduction to advanced error control techniques: HARQ, turbo codes, and LDPC codes.
3.	**Data Encryption and Decryption (8 h):** Introduction to cryptosystems, secrecy of a cipher system, symmetric key cryptosystem: stream ciphers and block ciphers, data encryption standard (DES), advanced encryption standard (AES), public key cryptosystems: principles and practical aspects, and RSA cryptosystem, pretty good privacy.

Module Code	EN4313	Module Title	Telecommunication Core Networks			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	CS3032
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Discuss the requirements of core networks.
2.	Discuss the impact of convergence to IP based protocols.
3.	Discus key design issues in core networks.
4.	Discuss key core network technologies.
5.	Design of Voice over IP (VOIP) and Video on Demand (VoD) networks.
6.	Analyze the applicability of Software Defined Networks (SDN) to different networking scenarios.
Outline Syllabus	
1.	**Evolution of Core Networks (2 h):** PDH, SDH, SONET, Frame Relay, ATM, IP.
2.	**Core Network Requirements (2 h):** Scalability, reliability, predictability, quality of service, traffic engineering, fault detection and monitoring, support of multiple services such as virtual private networks, optimal utilization of infrastructure.
3.	**Signaling (4 h):** Signaling in IP based and mobile core networks.
4.	**Convergence (2 h):** Convergence of multiple services to IP (voice, video conferencing, video streaming, video on demand, quality of service expectations, best effort nature of packet networks.
5.	**Design of core networks (4 h):** Design decisions related to core network requirements, analyze the limitation of LAN technologies in terms of scalability and monitoring.
6.	**Design of VOIP and Video on Demand Networks (4 h):** Analysis of requirements, technologies for voice and video compression, elements of a VOIP and video on demand networks, signaling.

Module Code	EN4363	Module Title	Microwave Communications			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN2053
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain the use of microwave communication systems in providing telecommunication and data communication solutions.
2.	Describe the use of satellites for communications.
3.	Design the RF links in terrestrial and satellite microwave communication systems and propose suitable protection methods for system reliability.
4.	Plan and propose microwave link solutions to the communication problems in the industry.
Outline Syllabus	
1.	**Principles of Terrestrial Microwave Communication (4 h):** Principles of tropospheric wave propagation: reflection, refraction, diffraction and absorption effects.
2.	**RF Link Design for Terrestrial Microwave Communication (6 h):** Path design, fading and fade margin, link power budget.
3.	**Reliability Measures (4 h):** Protection methods and link configurations.
4.	**Introduction to Satellite Systems (4 h):** Concept, history, orbits, footprints, frequency bands, constellations, Subsystems in a satellite, satellite payload, digital modem techniques, applications.
5.	**Satellite Communication Link Design and Analysis (8 h):** Satellite RF link path design, fading and fade margin, satellite link power budget, antennas.
6.	**Codec design for Satellite Communications (2 h):** Basic principles of speech/video coding and their usage in satellite communication systems. Error control for satellite communications systems.

Module Code	EN4553	Module Title	Machine Vision			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN2550
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Apply image processing algorithms to solve real-world problems.
2.	Implement representative vision algorithms that solve common machine vision problems.
3.	Design machine-vision systems that solve real-world problems.
4.	Using software tools and languages used in vision algorithm development and implementation.
5.	Describe current developments in machine vision.

Outline Syllabus	
1.	**Introduction and Revision (2 h):** Image enhancement in optical and medical images, restoration, compression, image segmentation, multiple view geometry, camera as a measurement devise.
2.	**Feature Detection and Matching (4 h):** Feature detectors (e.g., Harris, DoG), scale, rotation, affine, and illumination invariance, feature descriptors (e.g., SIFT, HOG), feature tracking.
3.	**Segmentation (4 h):** Watershed segmentation, mean-shift segmentation, active contours, intelligent scissors, normalized cuts, level sets, graph cuts, applications of segmentation.
4.	**Multi-view Geometry (4 h):** Estimation of transformations, RANSAC, cameras, camera calibration, triangulation, epipolar geometry, structure from motion, factorization, bundle adjustment, dense correspondence, multi-view stereo, applications of multi-view geometry.
5.	**Motion (4 h):** Parametric motion, image stitching, sparse optic flow, dense optic flow, layered motion, applications of motion analysis.
6.	**Detection and Recognition (6 h):** Object detection, face recognition, bag-of-words model, part based model, recognition with segmentation, learning from large image collections.
7.	**Recent Topics (2 h):** E.g., vision for graphics, video processing, activity recognition.
8.	**Vision Project (2 h):** Implementing a recent research paper that solves a problem appealing to the student.

Module Code	EN4563	Module Title	Robotics			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN3143
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify and describe different types of robots and their applications.
2.	Kinematic analysis of robot arms.
3.	Plan a motion profile for robot manipulators.
4.	Design a robot manipulator using software tools.
5.	Control system design for robot manipulators.
6.	Discuss advance applications of robotics.

Outline Syllabus	
1.	**Introduction (4 h):** The history and background of robotics, various robotic systems and applications (robotic surgery, planetary robots, aerial robots, underwater robots, humanoids, etc.) industrial robot manipulators (Cartesian, cylindrical, SCARA, articulated).
2.	**Robot Manipulator Kinematics (8 h):** Co-ordinate transformation, Euler angles, fixed angles, direction cosine matrix, Euler parameters, comparison between different types of robot manipulators, DH table, rotation matrix, homogeneous transformation matrix, Kinematics and inverse kinematics of robot manipulators, Jacobian and singularity, velocity mapping between joint and Cartesian spaces, static equilibrium.
3.	**Motion Planning (4 h):** Cartesian space and joint space trajectory planning, Cubic polynomials, splines, straight-line trajectories, control systems for robot manipulators
4.	**Robot Manipulator Design (4 h):** Joint and link configuration, design in solid works, joint motor selection, encoder selection, simulation and verification.
5.	**Manipulator Control (4 h):** Joint position control, inverse Jacobian control, stiffness, and compliance, force-position compliant control.
6.	**Advance Robotic Systems (4 h):** System design of advance robotic systems such as telesurgery robots, autonomous flying robots, telepresence robots, self-driving cars and humanoid robots.

Module Code	EN4922	Module Title	Research Project			
Credits	5.0	Hours/Week	Lectures	-	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Explain specific issues related to the chosen research topic based on how concepts have been built up through cross referencing of related research material.					
2.	Demonstrate skills of critical comparison with similar research topics.					
3.	Demonstrate specific skills related to research methodologies.					
4.	Demonstrate programming/analytical skills required for advanced research.					
5.	Write a research paper of acceptable quality.					
Outline Syllabus						
1.	Research methodologies, significance of literature survey, search methodologies, formulating research ideas, referencing research.					
2.	Reading and reviewing research articles, formalized methods of conducting a research, developing and implementing algorithms.					
3.	Writing research reports, preparing a paper for publication based on research outcomes.					

Semester 8 Module Information

Module Code	EN4020	**Module Title**	Advance Digital Systems				
Credits	3.0	**Hours/Week**	**Lectures**	2	**Pre/Co-requisites**	EN3031	
GPA/NGPA	GPA		**Lab/Assignments**	3			

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Discuss characteristics of complex digital systems.
2.	Analyze complex digital systems.
3.	Discuss the mapping of performance requirements to design decisions.
4.	Discuss the methods for functional and logic verification.
5.	Design of a 16-bit RISC processor with cache-based memory hierarchy.
6.	Design and implement bus architecture for low speed and high-speed peripherals.
7.	Discuss the need for System on Chips and Network on Chips.
Outline Syllabus	
1.	**Complex Digital Systems (4 h):** Analysis of characteristics such as throughput, timing, stability, memory and area footprints, power budget, signal integrity, clock recovery and synchronization, multiple clock domains, inter-connectivity of modules using FIFOs.
2.	**Analysis of Complex Digital Systems (6 h):** Example systems such as processors (non-pipelined and pipelined, video decoders and encoders, their timing and throughput requirements, connectivity to other dependent modules.
3.	**Verification (4 h):** Functional and logic verification, OVM (Open Verification Methodology) and UVM (Universal Verification Methodology), coverage, introduction to formal verification methodologies.
4.	**Design and Implement Complex Digital Systems (8 h):** Design methodologies (RTL and high-level synthesis), design of a 16-bit RISC pipelined processor and its interfacing to memory hierarchy (cache and primary memory).
5.	**Design and Implement Simple Bus Architectures (4 h):** Analysis of requirements, design decisions, HDL implementation and verification.
6.	**System on Chip and Network on Chip (2 h):** Basic principles and methodologies for implementation.

Module Code	EN4233	Module Title	Industrial Electronics and Automation			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN3143
GPA/NGPA	GPA		Lab/Assignments			

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Specify the characteristics of sensors and actuators required for an automated system design.
2.	Model a control system.
3.	Select and integrate different modules to work in different environments.
4.	Implement a control system for a real-world application.
Outline Syllabus	
1.	**Types of Sensors and Actuators (6 h):** Digital sensors, analog sensors, and sensor specifications, introduction to different types of actuators including servo motors, DC motors, AC motors, grippers, manipulators, linear actuators, hydraulic and pneumatic types.
2.	**System Modeling and Control (6 h):** Control systems and control techniques, systems identification and modeling.
3.	**Type of Systems (8 h):** SCADA systems and PLCs, peripheral devices and data communication standards.
4.	**Systems Integration (8 h):** Sensors, actuators and signal processing.

Module Code	EN4323	Module Title	Optical Fiber Communications			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN2053 EN2083
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Investigate and evaluate the capabilities of optical components used in practical networks and research and development.
2.	Identify and investigate the underlying innovations behind emerging technologies in fiber optic communications.
3.	Design a cost-effective solution for real world optical link design problems.
4.	Identify the practical aspects of the optical system and apply the knowledge in field activities.
5.	Discuss telecommunications core, metro and access network infrastructure and its role in forming an integrated telecommunications system.

Outline Syllabus	
1.	**Introduction (1 h):** Introduction to optical communication systems, history of optical fiber and optical communication systems, comparison with other wired and wireless media.
2.	**Optical Fiber (4 h):** Optical fiber as a dielectric waveguide, optical fiber construction and types, multimode and single mode fibers, geometric/ray optics (Snell's law, total internal reflection, numerical aperture and V-number), wave optics (wave equation and its solutions, fiber modes).
3.	**Optical Sources (4 h):** Light emitting diodes (LED's), laser diodes and characteristics, different types of LDs such as DFB, DBR, ECL, VCSEL, MLL and tunable lasers.
4.	**Optical Detectors and Receivers (1 h):** PIN photodiode, avalanche photo-diode and other photo detectors and sensors.
5.	**Optical Modulators and Modulation Techniques (2 h):** Direct and external modulation, different types of modulators (electro optic, electro absorption and acousto-optic), different optical modulation types (ASK, FSK, nPSK, nQAM), non-return to zero and return to zero.
6.	**Optical Amplifiers (4 h):** Optical amplification theory (based on EDFA), EDFA characteristics and noise (ASE), noise figure, different types of optical amplifiers (REDOA, RA, SOA, PSA) and their applications.
7.	**Optical Channel Impairments (3 h):** Optical fiber attenuation, dispersion, inter-symbol interference and introduction to non-linear effects.
8.	**Optical Measurement Techniques (3 h):** Eye opening factor (EOF), Optical signal to noise ratio (OSNR), Q-factor, and bit error rate (for ideal condition and with different impairments).
9.	**Optical Network Components and Link Design (2 h):** Link budget calculations and selection of optical components.
10.	**Optical Networks (6 h):** Optical fibrenetworks (core, metro and access), different types of optical access networks (FTTx and PON), optical transmission and switching techniques (SONET, OTN, and PON standards).

Module Code	EN4333	Module Title	Microwave Engineering			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Apply principles of electromagnetics to understand the behavior of microwave components and systems.
2.	Use s-parameters to characterize microwave components.
3.	Explain the operating principles of basic microwave devices.
4.	Use basic microwave devices in designs effectively, observing safety precautions.
5.	Analyze frequently employed antennas at microwave frequencies.
Outline Syllabus	
1.	**Microwave Transmission Lines and Components (4 h):** Transmission line theory, impedance matching, coaxial lines, microstrips, filters, bends, couplers, junctions, lumped components.
2.	**Microwave Circuit Theory (6 h):** s-parameters, signal flow graphs, transducer power gain.
3.	**Passive Components (6 h):** Terminations, attenuators, reactive stubs, cavity resonators, T junctions, hybrid ring, directional couplers, slotted lines, ferrite filters, isolators, circulators, phase shifters.
4.	**Microwave Tubes (3 h):** Magnetron, klystron, reflex klystron, traveling wave tube.
5.	**Application of Microwave Semiconductor Devices (6 hrs):** Bipolar junction transistors, field effect transistors Gunn diode, PIN diode, varactor diode, tunnel, diode, backward diode, Schottky diode, point contact diode, IMPATT diode.
6.	**Microwave Antennas (3 h):** Horn antenna, helical antenna, phased arrays, reflector antennas, patch antennas.

Module Code	EN4353	Module Title	Radar and Navigation			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN1060 EN2510
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Distinguish between different radar system architectures and configurations, and critically asses their specializations.
2.	Identify different navigational aids.
3.	Identify the role of satellite communication in modern navigation.
4.	Design of radar systems and navigational aids, by applying fundamental engineering concepts found in microwave engineering, atmospheric propagation of electromagnetics, electronics and signal processing.
5.	Critically assess system parameter values needed for successful operation of radar and navigational systems under different operating environments.
6.	Define pulse compression and analyze the time frequency characteristics of different waveforms.
7.	Investigate target tracking using Bayesian philosophy, design appropriate algorithms for simple and maneuvering targets under different environments.
Outline Syllabus	
1.	**Radar System Overview (2 h):** Modern radar systems for different applications, radar equation in free space, attenuation correction.
2.	**Radar Receiver System Analysis (8 h):** Target detection in noise, constant false alarm rate detection, match filter ambiguity function, pulse compression using waveform modulation.
3.	**Radar Target Tracking (6h):** Introduction Bayesian filtering leading to Kalman filtering of single non maneuvering target, tracking of maneuvering targets using nonlinear filtering (EKF, UKF, particle filtering), target tracking with clutter and ECM.
4.	**MIMO Radar (4hours):** Phase array radar, adaptive beam forming, cognitive radar, radar networks.
5.	**Navigational Aids En-route and Landing (4 h):** Secondary radar, DVOR / DME, instrumental landing systems.
6.	**Satellite Based Navigation System (4 h):** Satellite based navigation, ground based / satellite based augmentation systems.

Module Code	EN4383	Module Title	Wireless and Mobile Communications			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain and assess various effects of the propagation channel on the received signal in a given application/propagation scenario.
2.	Use appropriate empirical and statistical channel models in design of a radio link in a given propagation environment.
3.	Explain relative merits and demerits of wireless communication technologies.
4.	Select a wireless technology or a combination of technologies to suit a given application.
5.	Plan a wireless communications system for a given environment in which it is to be deployed.
Outline Syllabus	
1.	**Overview of Wireless Communications (1 h):** Evolution, applications and requirements, and technical challenges.
2.	**Signal Propagation over Wireless Channels (8 h):** Propagation mechanisms, propagation loss: free-space path loss, ray tracing, empirical models, indoor propagation models, statistical description: large scale fading, combined pathloss and shadowing, outage probability, small scale fading, diversity reception, Doppler spectra and temporal channel variations, wideband channel characterization: WSSUS model, delay spread, coherent bandwidth, coherent time, and coherent distance, and channel models in wireless standards.
3.	**MIMO Communications (4 h):** MIMO system model, MIMO channel models, space-time coding, spatial multiplexing, and beamforming.
4.	**Cellular Mobile Communication Systems (7 h):** Evolution of cellular systems, principles and operation of cellular systems, interference reduction techniques, capacity considerations, mobile communication standards, and introduction to radio network planning.
5.	**Wireless Network Standards (4 h):** Wireless LANs, wireless MANs, short range wireless networks, standards, capabilities and applications, broadband wireless networks, and integration of different types of wireless networks.
6.	**Wireless Sensor Networks (4 h):** Introduction to sensor networks and applications, issues in sensor networks in comparison to conventional wireless networks, special design considerations in energy conservation, routing etc.

Module Code	EN4393	Module Title	Information Theory			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignment	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain the operational meanings of and determine entropy, relative entropy and mutual information of random variables characterizing different types of information sources.
2.	Apply the fundamental concepts of information theory to determine the channel capacity of discrete memoryless channels.
3.	Apply the Shannon-Hartley theorem for information transmission on Gaussian channels to determine the channel capacity.
4.	Mathematically analyze the capacity of Gaussian channels and fading channels.
5.	Use the water-filling algorithm to determine the optimal power allocation for parallel Gaussian channels.
6.	Explain information theoretic results as the fundamental limits on the performance of communication systems.
Outline Syllabus	
1.	**Introduction to Information Theory (1 h):** Historical background, introduction to information theory and its applications.
2.	**Information Sources and Measures (7 h):** Information sources: memoryless and Markov sources, information measures: entropy, relative entropy, and mutual information, chain rules, Jensen's inequality, data processing inequality, Markov chains, and entropy rates.
3.	**Asymptotic Equipartition Property (2 h):** Asymptotic equipartition property theorem, consequences of the AEP, high-probability sets and typical set.
4.	**Capacity of Discrete Memoryless Channels (8 h):** Definition of channel capacity, examples of channel capacity, symmetric channels, jointly typical sequences, symmetric channels, properties of channel capacity, channel coding theorem, and zero error coding.
5.	**Information Measures for Continuous Random Variables (2 h):** Definitions, differential entropy, joint and conditional differential entropy, relative entropy and mutual information, and properties.
6.	**Capacity of Gaussian Channels (8 h):** Capacity of Gaussian channel, converse to the coding theorem, capacity of band-limited channels, capacity of parallel channels and capacity of fading channels.

Module Code	EN4403	Module Title	Mobile Computing			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignment	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Define mobile computing, and discuss its applications, architectures, current status and future trends.
2.	Discuss components of the mobile ecosystem and interactions among them.
3.	Analyze strengths existing in the mobile computing ecosystem: enhancing computing with mobility, sensing, location, context etc.
4.	Analyze challenges existing in the mobile computing ecosystem: energy, size, computing power, communications unreliability, security vulnerabilities.
5.	Discuss how mobile applications leverage the strengths and overcome the challenges.

Outline Syllabus	
1.	**Introduction to Mobile Computing (4 h):** Definitions in use and their interpretation, different aspects, components and their congruence as an ecosystem, application areas, advantages, issues, challenges and solutions. Innovations and future trends.
2.	**Protocols Supporting Mobility (3 h):** Mobile network layer protocols, mobile-IP, dynamic host configuration protocol (DHCP), mobile transport layer protocols, mobile-TCP, indirect-TCP, wireless application protocol (WAP), cross-layer interactions to support mobile computing. cross-layer interactions to support mobile computing.
3.	**Mobile Application Architecture (3 h):** Application models such as extended client-server, peer-to-peer model, wireless internet model, mobile agent model, messaging model, smart client model and cloud architectures. comparison of architectures and their suitability for different applications. architecture design guidelines. guidelines for the design of presentation, business, data access and service layers. guidelines for designing a communication approach for the devices and the infrastructure supporting them. deployment choices, effect of deployment strategy on performance, security, and other quality attributes.
4.	**Location (3 h):** Different technologies available for location detection, location detection methods, location-based services, location-aware mobile applications. Privacy issues related to location data.
5.	**Context (3 h):** The definition of context, context categories, approaches to context awareness, use of context in mobile computing, design principles for context aware applications.
6.	**Energy Management in Mobile Computing (3 h):** Energy management strategies in mobile devices, sensors and communications.
7.	**Interaction Design in Mobile Computing (3 h):** Principles of interaction design, device limitations, favorable technology trends, examples.
8.	**Mobile Cloud Computing (3 h):** Classification of mobile cloud computing categories: cloud of mobile devices as a service, cloud computing services/resources available for mobile devices.
9.	**Privacy, Security and Trust in Mobile Computing (3 h):** Privacy, security and trust issues in mobile computing due to distributed nature, mobile devices, mobility, and disconnections. Security controls in mobile computing systems. Security policies and domains. Privacy and security in mobile cloud computing.

Module Code	EN4420	Module Title	Advanced Signal Processing			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN1060 EN2510
GPA/NGPA	GPA		Lab/Assignment	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify and formulate signal processing problems in many engineering applications.
2.	Differentiate different optimality criteria in estimation, and design appropriate estimators for given applications.
3.	Discuss the analytical framework required for different estimation and detection approaches.
4.	Analyze multi rate signals and design such systems for a given application.
5.	Analyze the effect of finite word length on the designed filters.
6.	Perform rigorous technical/mathematical analysis on real world signal processing scenarios.

Outline Syllabus	
1.	**Optimal Parameter Estimation (8 h):** Estimation and error functions, minimum variance unbiased estimation, least mean square/recursive least filters as optimal estimators, maximum likelihood estimators, Bayesian estimation leading to Weiner and Kalman filtering.
2.	**Statistical Detection Theory (6 h):** Neyman-Pearson theorem, minimum Bayes risk detector, generalized likelihood ratio test, asymptotic properties of different detectors.
3.	**Multi-rate Signal Processing (4 h):** Fundamentals of multi-rate signal processing, multistage implementation, maximally decimated filter banks, perfect reconstruction, introduction to wavelet transform.
4.	**Analysis of Finite Word Length Effects (2 h):** Quantization errors, filter robustness and stability.
5.	**Case Study 1: Spectrum Estimation of the ECG Signal (2 h):** Overview of spectrum estimation methods (periodogram, Blackman-Tukey transformation, windowing methods, ESPIRIT, MUSIC), signal detection, muscle signal and noise estimation.
6.	**Case Study 2: Distributed Particle Filter Processing in Sensor Networks (2 h):** Likelihood function with sensor detection, distributed particle filter, quantization of received power, particle filter implementation.
7.	**Case Study 3: State Estimation of a Quadrotor Platform (2 h):** System equation, linearization, extended Kalman filter development.
8.	**Case Study 4: Applications of Multi-Rate Signal Processing and Wavelets in Digital Communications (2 h):** CDMA receivers, multi-tone modulators, etc.

Module Code	EN4573	Module Title	Pattern Recognition and Machine Intelligence			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN2550
GPA/NGPA	GPA		Lab/Assignment	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Investigate the capabilities of classifiers and learning algorithms.
2.	Recommend the best classifier to tackle real life pattern recognition problems.
3.	Apply pattern recognition techniques in solving industry and research problems.
Outline Syllabus	
1.	**Introduction (4 h):** Basic concepts of pattern recognition, applications of pattern recognition in biomedical engineering, data mining, signal processing, computer security, natural language processing, and computer vision, probability distributions (binary variable, multinomial variable, Gaussians, the exponential family), non-parametric methods.
2.	**Decision Trees (4 h):** Discrete attribute decision trees, continuous attribute decision trees, learning algorithms (ID3, C4.5, CART, Random Forest), cut point selection.
3.	**Linear Models for Regression and Classification (6 h):** Linear basis function model, the bias-variance decomposition, Bayesian linear regression, the evidence approximation. discriminant functions, probabilistic generative models, probabilistic discriminative models, the Laplace approximation, Bayesian logistic regression.
4.	**Kernel Methods and Sparse Kernel Machines (4 h):** Dual representations, constructing kernels, radial basis function networks, Gaussian process, maximum margin classifiers, relevance vector machines.
5.	**Graphical Methods (2 h):** Bayesian networks, Markov random fields, inference in graphical methods.
6.	**Mixture Models and EM (2 h):** k-means clustering, mixture of Gaussians.
7.	**Sampling Methods (2 h):** Basic sampling algorithms, Markov chain Monte Carlo, Gibbs sampling.
8.	**Continuous Latent Variables (2 h):** Principal component analysis, probabilistic PCA.
9.	**Sequential Data (2 h):** Markov models, hidden Markov models, linear dynamical systems.

Module Code	EN4583	Module Title	Advances in Machine Vision			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN2550 EN4553
GPA/NGPA	GPA		Lab/Assignment	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify open machine vision problems.
2.	Comprehend current literature in machine vision.
3.	Implement a recent algorithm in machine vision.
4.	Propose novel solutions to open vision problems.

Outline Syllabus	
1.	**Introduction (4 h):** Doing a literature search, journals and conferences in vision, solved problems in vision, areas of current research interest in vision, data sets and grand challenges.
2.	**Detection And Recognition (6 h):** Features, generative vs. discriminative, bag-of-words model, part-based model, scene understanding, big data in vision.
3.	**Segmentation (6 h):** Segmentation algorithms, advances in segmentation, segmentation with recognition, co-segmentation.
4.	**Reconstruction (6 h):** Reconstruction methods and applications, reconstruction from large collections.
5.	**Activity Recognition (6 h):** Video features, action recognition, activity recognition, behavior analysis for games.

Module Code	EN4593	Module Title	Autonomous Systems			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignment	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe a set of autonomous systems and their basic operations.
2.	Explain the major difficulties in designing autonomous systems, and how to overcome those.
3.	Design an intelligent system.
4.	Design an intelligent autonomous system and simulate it using software tools.
Outline Syllabus	
1.	**Introduction to Autonomous Systems (6 h):** Introduction to autonomous systems, basic system design of autonomous systems, control algorithms and challenges.
2.	**Localization Navigation and Control (10 h):** Sensor fusion, Kalman filter, occupancy grid, potential field method, GPS-INS navigation, IMU theory, behaviour-based control, controller fusion, neural networks and fuzzy logic based control techniques, control under modelling errors and uncertainties.
3.	**Intelligent Systems (8 h):** Fuzzy systems and control, neural network based systems, adaptive neuro-fuzzy systems (ANFIS), MATLAB implementation.
4.	**Design Autonomous Systems (4 h):** Supervisory control, task-resolved motion control, wave parameters in teleoperation, task planning.

Module Code	EN4430	Module Title	Analog IC Design			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignment	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain the analog IC design concepts.
2.	Recognize the technical challenges in analog IC design.
3.	Demonstrate the proficiency in schematic and layout design.
4.	Design and analyze the analog IPs at schematic and layout stages.

Outline Syllabus	
1.	**Analog IC Design Concepts (8 h):** CMOS devices and its fabrication process, Analog design techniques, Analog IC design flow.
2.	**Circuit Simulations (4 h):** Define test modes, Simulation techniques.
3.	**Analog Devices (8h):** Schematic design and simulations of PLL, CDR, PoR, clock modules.
4.	**Analog IP Development (4 h):** Analog IP design flow, floorplan and IO selection, mixed signal design flow.
5.	**Design Layout (6 h):** Familiarize with tools required for layout, and layout verification, design related problems and fixes.

Module Code	EN4603	Module Title	Digital IC Design			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignment	3		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain the digital IC design concepts.
2.	Recognize the technical challenges in digital IC design.
3.	Demonstrate the proficiency in VLSI design tools widely used in industry.
4.	Design and analyze the digital VLSI circuits at various design stages from functional design, logic design, circuit design, to physical design.

Outline Syllabus	
1.	**Digital Design Concepts (10 h):** Introduction to digital IC design, Digital design basics, RTL to netlist mapping, synthesis, high fan-out synthesis, clock tree synthesis.
2.	**Design for Test (4 h):** Define test modes, DFT insertion techniques.
3.	**Backend Design (6 h):** Floor plan, place & route, layout verification, IO design.
4.	**IP Development (4 h):** IP design flow, IO definition, test methodologies, characterization of IPs.
5.	**RTL2GDS Flow (6 h):** Familiarize with tools required for synthesis, place & route, timing analysis, and layout verification, design related problems and fixes.

Biomedical Engineering Specific Module Information

Following modules are offered under Biomedical Engineering

Module Code	BM1011	**Module Title**	Engineering in Medicine and Biology			
Credits	2.0	**Hours/Week**	**Lectures**	1	**Pre/Co-requisites**	-
GPA/NGPA	NGPA		**Lab/Assignment**	3/1		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Recognize the historical perspective of biomedical engineering.					
2.	Describe major areas of biomedical engineering.					
3.	Discuss the moral and ethical issues in medical research and development.					
Outline Syllabus						
1.	**Biomedical Engineering: A Historical Perspective (2 h):** Evolution of the modern healthcare system, roles of biomedical, professional status of biomedical engineering, professional societies, clinical engineering					
2.	**Biomechanics and Related Areas (3 h):** Mechanics of physiological systems, rehabilitation engineering and prosthetics					
3.	**Chemical and Material Engineering Applications in Biology and Medicine (3 h):** Transport phenomena, biomaterials, biotechnology and tissue engineering					
4.	**Biomedical Instrumentation (2 h):** Biosensors, instrumentations, biosignal processing, standards, and safety					
5.	**ICT in Medicine (2 h):** Physiological modeling and simulation, medical informatics, computational cell biology					
6.	**Moral and Ethical Issues in Medical Research And Development (2 h):** Morality and ethics, human experiments, and ethical issues biomedical activities					

Module Code	BM2011	Module Title	Human Anatomy and Physiology I			
Credits	3.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignment	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Describe the human body and its constituents.					
2.	Explain the organization of the body.					
3.	Discuss the communication needs of human body and related systems and their disorders.					
Outline Syllabus						
1.	**Introduction to the Human Body and the Chemistry of Life (3 h)**					
2.	**The Cells, Tissues and Organization of the Body (6 h)**					
3.	**Communication Needs of the Body (27 h):** Blood, cardiovascular system, lymphatic system, nervous system, special senses, and endocrine system.					

Module Code	BM2020	Module Title	Human Anatomy and Physiology II			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	BM2011
GPA/NGPA	GPA		Lab/Assignment	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe the intake of raw materials and elimination of waste in the human body and the disorders of the relevant physiological systems.
2.	Explain the protection and survival methods of the human life and the disorders of the relevant physiological systems.
Outline Syllabus	
1.	**Intake of Raw Materials and Elimination of Waste (14 h):** Respiratory system, introduction to nutrition, digestive system, urinary system.
2.	**Protection and Survival of the Human Body (12 h):** Skin, resistance and immunity, musculoskeletal system, introduction to genetics, reproductive system.

Module Code	BM2101	Module Title	Analysis of Physiological Systems			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	BM2011 BM2020
GPA/NGPA	GPA		Lab/Assignment	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Compare engineering and biological systems using concepts from systems analysis.
2.	Construct analytic and computational models to analyze the regulation of the respiratory, cardiovascular and saccadic eye movement systems.

Outline Syllabus	
1.	**Modeling Strategies in Physiology (4 h):** Hybrid approaches and model reduction, compartmental models, methods and tools for identification of physiologic systems.
2.	**Respiratory Models and Control (6 h):** Models for respiratory mechanics, method of identifying abnormalities respiration, and ventilators.
3	**Cardiovascular Models and Control (8 h):** Chemoreflex regulation of respiration, cardiovascular mechanics, heart-rate variability, cardiac electrophysiology, pacemakers, and defibrillators.
4	**The Fast Eye Movement Control System (6 h):** Saccade characteristics, saccadic eye movement models, and saccade control mechanism.

Module Code	BM2900	Module Title	Field Visits			
Credits	1.0	Hours/Week	Lectures	-	Pre/Co-requisites	-
GPA/NGPA	NGPA		Lab/Assignment	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Perceive the application of engineering in medicine.					
Outline Syllabus						
1.	The course will be in the form of one or more field visits to places of interest to Biomedical Engineering graduates. These will include, but not limited to healthcare facilities, medical device design and manufacturing companies, and medical technology service providers.					

Module Code	BM3121	Module Title	Medical Imaging			
Credits	4.0	Hours/Week	Lectures	3	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignment	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Discuss physics of how signals, from which images are formed, are obtained
2.	Discriminate characteristics of different medical imaging modalities
3.	Compare the effect of different imaging modalities on the human body
4.	Interpret various parameters of medical images for measurements and analysis
Outline Syllabus	
1.	**X-ray Imaging (4 h):** Projection x-ray principles and equipment, dose and exposure, attenuation coefficient, clinical x-ray procedures, digital radiography, x-ray computed tomography (CT).
2.	**Magnetic Resonance Imaging (8 h):** Nuclear magnetic resonance (NMR), magnets and coils, spatial encoding, k-space, image quality, contrast manipulation, pulse sequences, functional MRI.
3.	**Ultrasound Imaging (4 h):** Ultrasound principle, transducer, ultrasound-tissue interactions, acoustic impedance, a-mode imaging, time gain compensation (TGC), beamsteering, b-mode imaging, resolution and penetration, Doppler ultrasound.
4.	**Nuclear Medicine (4 h):** Radiopharmaceuticals, gamma camera, single photon emission computed tomography (SPECT), positron-emission tomography (PET).
5.	**Optical and Thermal Imaging (4 h):** Medical thermography, thermographic equipment, and optical coherent tomography (OCT).
6.	**Image Perception and Quality (2 hrs)**

Module Code	BM3990	Module Title	Industrial Training			
Credits	6.0	Hours/Week	Lectures	-	Pre/Co-requisites	-
GPA/NGPA	NGPA		Lab/Assignment	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify the differences between academic and industrial environments.
2.	Evaluate the training institutions relevance to engineering and engineering management.
3.	Adhere to engineering ethics, industrial safety standards and processes.
4.	Present the findings in a training report.

Outline Syllabus	
1.	**Induction:** This is an initial period to help the student in the transition from academic to industrial life. The students should meet a mentor to discuss the contents and the objectives of training. Students should also receive information about the training organization, its products or services and the terms and conditions of employment.
2.	**Practical Skills:** During this period the student should receive instructions in the practical skills essential for future employment. It should also include an appreciation of the work of others in converting an engineering design into a final product (if appropriate).
3.	**General Engineering Training:** In a large organization this should include an introduction to the work done in a number of departments. Under these circumstances, the student may eventually be working as a member of a team in the organization. The student should be made aware of the management and administration sectors of the organization.
4.	**Directed Objective Training:** The major part of the training should have directed application to the activity which the student intends to follow after the training program (activities should be relevant to the major in which the student will be graduating in). At this stage the student should be encouraged to work on a real project* and be given increasing responsibility for independent work to establish interest and confidence in his/her work.
*	*This is an individual project, but supervisors can divide a complex project into sub areas to allow a group of students to collaborate. Students are evaluated individually*

Module Code	BM3180	Module Title	Scientific Communications for BME			
Credits	2.0	Hours/Week	Lectures	1	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignment	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Adopt widely accepted procedure in scientific research and publications.
2.	Communicate effectively in both oral and written formats.
Outline Syllabus	
1.	**Scientific Conduct and Method (2 h)**
2.	**Scientific Writing (2 h):** Abstracts, project outlines, journal papers, grant proposals.
3.	**Oral and Poster Presentations (4 h):** Structure, function, content.
4.	**Communication with Lay Audiences (2 h)**
5.	**Intellectual Property and Disclosures (2 h)**

Module Code	BM3190	Module Title	Biostatistics and Ethics for BME			
Credits	1.0	Hours/Week	Lectures	-	Pre/Co-requisites	-
GPA/NGPA	NGPA		Lab/Assignment	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify issues in biomedical research ethics.
2.	Discuss the basics of setting up and running pre-clinical and clinical trials.
3.	Interpret experiment results using basic biostatistics.

Outline Syllabus	
1.	**Ethics in Health Research:** International guidelines, good clinical practice, research ethics boards, research involving animals.
2.	**Basic Biostatistics:** Fundamental concepts, common statistics.
3.	**Research Integrity:** Collegiality and authorship, collaborative research, copyrights, licenses and patents.
4.	**Conducting Clinical Trials:** Types of clinical trials, the clinical protocol and trial design, institutional overhead, confidentiality and informed consent, data handling and record keeping, adverse events, audit and the audit trail, close out.

Module Code	BM4200	Module Title	Research Project			
Credits	10.0	Hours/Week	Lectures	-	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify a problem of sufficient complexity in medicine that can be solved using the technologies learnt during the undergraduate career within a given time frame.
2.	Explain specific issues related to the chosen research topic based on how concepts have been built up through cross referencing of related research material.
3.	Analyze different approaches to solve the identified problem.
4.	Develop the solution using the selected approach.
5.	Evaluate the effectiveness of the solution.
6.	Justify the methods adopted in the solution.
7.	Prepare the undergraduate research thesis and a research paper for publication.

Outline Syllabus	
1.	**Investigation Stage:** The student should be capable of independently referring to books, papers, academic literature and electronic resources to justify their choice of project. Conduct a literature survey in order to academically support any claims, technologies and methods used in the research project. This phase should also be used to determine if there are other methods that have been used to address the same or similar problems.
2.	**Implementation Stage:** Once the preliminary investigation is carried out and a project of appropriate complexity is chosen, the next stage is to design and implement the research. Identifying the proper approach of implementation for completing the research successfully. At the implementation stage, the student is allowed to alter or modify the methodologies proposed in the previous phase depending on any new information available at this stage. Students are expected to design proper experiments for evaluating their research outcome against the ground truth and/or existing methods of similar work.
3.	**Presentation Phase:** Placing the work in context and presenting it effectively is also an important part of the project. Effective presentation of the project material and a well structured thesis is expected for the satisfactory completion of the research project. The documentation and knowledge preservation includes a presentation, thesis DVD with structured information, a viva, and a draft paper for publication.

Module Code	BM4111	Module Title	Medical Electronics and Instrumentation			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe the operational principle of transducers and electrodes used in medical instrumentation.
2.	Explain the principles of operation of medical devices.
3.	Describe the use of therapeutic equipment in medicine.
4.	Analyze the effects of medical instruments on the human body.
Outline Syllabus	
1.	**Measuring, Recording, and Monitoring Instruments (14 h):** Fundamentals of medical instrumentation, physiological transducers, monitoring systems, biomedical telemetry, physiological measurements, and patient safety.
2.	**Therapeutic Equipment (10 h):** Cardiac pacemakers and defibrillators, dialysis systems, surgical instruments, life supporting devices and radiotherapy equipment**.**

Module Code	BM4151	Module Title	Biosignal Processing			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	EN1060 EN2510
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe the generating process of key biosignals.
2.	Analyse different type of biosignals to get a deeper contextual understanding.
3.	Demonstrate the understanding of biosignal representation techniques and their applicability to the analysis of biosignals.
4.	Describe the effects of noise on biosignals and removal methods of such noise.
5.	Demonstrate the ability to implement key algorithms on software and evaluate their performance.
Outline Syllabus	
1.	**Physiology and Characteristics of Bioignals (2 h):** Introduction.
2.	**Electrocardiogram (6 h):** Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications, ECG filtering and frequency analysis, QRS detection, P & T wave detection.
3.	**Effect of Noise on Medical Signal Processing (4 h):** Noise characteristics, noise reduction techniques, adaptive signal processing, LMS, RLS.
4.	**Electroencephalogram (6 h):** Source of EEG signals, measurement of EEG signals, frequency domain analysis of EEG, modeling of EEG signals (AR, ARMA), EEG artifacts, use of software tools to analyze EEG.
5.	**Signal Representation by Basis Functions (4 h):** Principal component analysis (PCA), independent component analysis (ICA).
6.	**Time-frequency Analysis of Biosignals (4 h):** Short-time Fourier transform (STFT), wavelet denoising, wavelet compression.
7.	**Oscillometric Wave and Speech Signals (2 h):** Blood pressure measurements using the oscillomertic wave and spectrographic analysis of speech signals.

Module Code	BM4301	Module Title	Medical Image Processing			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Discuss principles of image reconstruction and visualization.
2.	Discuss the advantages and limitations of imaging techniques and identify which technique is suitable to a given application.
3.	Describe morphological image processing.
4.	Differentiate medical image segmentation algorithms.
5.	Discuss medical image registration techniques.
6.	Design an image processing application for medical images.

Outline Syllabus	
1.	**Image Reconstruction and Visualization (4 h):** Fundamentals, image enhancement, popular software libraries, texture and motion analysis.
2.	**Morphological Image Processing (6 h):** Binary images, gray-scale images.
3.	**Medical Image Segmentation (4 h):** Region growing, watershed, level-set segmentation, deformable models.
4.	**Medical Image Registration and Fusion (6 h):** Geometric features, similarity measures, modelling tissue deformation, finite element analysis, tissue deformation models.

Module Code	BM4321	Module Title	Genomic Signal Processing			
Credits	3.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe the underlying processes of the genetic code of living organisms.
2.	Apply machine learning algorithms for processing genomic data.
3.	Develop new algorithms for novel problems in genomics.

Outline Syllabus	
1.	**Introduction (2 h):** Motivation and challenges for genomic signal processing, hereditary diseases, contagious disease control, influence of genes on cancer, heart disease, diabetes, drug efficacy etc. genetic engineering and phylogenetic analysis.
2.	**The Genetic Code (4 h):** DNA, RNA and proteins. DNA organization in prokaryotes, simple eukaryotes and higher eukaryotes. Viruses. DNA sequencing methods.
3.	**DNA Sequence Alignment (4 h):** Computational challenges, local, global and overlap alignment, alignment algorithms.
4.	**Use of Markov Chains, Hidden Markov Models and the Viterbi Algorithm in GSP (6 h)**
5.	**Clustering Algorithms and Advanced Topics (4 h):** Oligonucleotide clustering, haplotypes, information theoretic approaches, parallel processing and hardware implementation of GSP algorithms, other emerging topics.

Module Code	BM4500	Module Title	Biomechanics			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe the fundamental areas of human biomechanics.
2.	Use mathematical models to describe human tissue, orthopaedic implants, limb replacements, and human motion.
3.	Apply principles of mechanics to biological systems of the human body.
Outline Syllabus	
1.	**Human Tissue and Modelling of Tissue (6 h):** Growth, structure and composition, mechanical properties, mathematical modelling of human tissue.
2.	**Joints and Movement of the Human Body (4 h):** Classification of joints, mathematical representation and calculation of joint movement. Why and how human movement is studied. Gait analysis and force measurements.
3.	**Materials in Biomechanics (6 h):** Types of implants and orthopaedic interventions, principles behind materials selection, procedure followed when introducing new materials.
4.	**Limb Replacement, Orthopaedic Implants and Materials Used (6 h):** Types of limb replacements and orthotic devices. Existing technology in developing and developed.

Module Code	BM4521	Module Title	Rehabilitation Engineering			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Discuss methods used to substitute disabled functions of human body.					
2.	Explain measurement tools and process used in rehabilitation engineering.					
3.	Describe operation of prosthetic and artificial organs.					
Outline Syllabus						
1.	**Rehabilitation Engineering Technologies (12 h):** Principles of application, orthopaedic prosthetics and orthotics, wheeled mobility, externally powered and controlled orthotics and prosthetics, Sensory augmentation and substitution, Augmentative and alternative communication, Measurement tools and processes in rehabilitation engineering.					
2.	**Prosthetic Devices and Assist Devices (6 h):** Cardiac prostheses, vascular grafts, artificial lungs and blood-gas exchange devices, orthopaedic devices, bone and cartilage grafts.					
3.	**Common Medical Devices and Support Systems (10 h):** Artificial kidney, peritoneal dialysis equipment, liver support systems, artificial pancreas, tracheal and oesophageal replacement devices, artificial skin and dermal equivalents.					

Module Code	BM4600	Module Title	Biomaterials			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Apply the fundamental principals in material science and chemistry, and how they contribute to biomaterial development and performance.
2.	Discuss different types of materials used in biomedical applications.
3.	Differentiate between artificial and bio-compatible materials.
4.	Develop methods for biocompatibility improvement and practical aspects of biomedical devices: sterilization, manufacturing, clinical trials, price of implants.
5.	Describe preservation techniques used with biomaterials.
Outline Syllabus	
1.	**Materials in Biomedical Applications (4 h):** Characteristics of material used in the human body (Metallic, ceramic, polymeric, composite, etc.).
2.	**Bio-compatible Materials (4 h):** Biodegradable polymeric biomaterials, tissue-derived biomaterials.
3.	**Tissue Replacements (6 h):** Soft tissue, hard tissue.
4.	**Materials Considered for Implants (6 h):** physical characteristics and compatibility with the bio environment.
5.	**Preservation Techniques for Biomaterials (4 h)**

Module Code	BM4620	Module Title	Biotechnology			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe cell structures and their functions.
2.	Illustrate use of technology principles in vaccine production and gene therapy.
3.	Outline principles of tissue engineering.
Outline Syllabus	
1.	**Cellular Bioprocesses (8 h):** Cell structure and their functions, cell membranes, energy and thermodynamics of cells, the genetic code, genetic engineering, enzymes, metabolomics, cell engineering.
2.	**Monoclonal Antibodies and their Engineered Fragments (2 h)**
3.	**Gene Therapy (2 h)**
4.	**Antisense Technology (2 h)**
5.	**Vaccine Production (2 h)**
6.	**Tissue Engineering (2 h):** Basic principles and considerations.
7.	**Drug Delivery (2 h):** Engineering targeted drug delivery methods and sustained release. Application of nanotechnology.

Offered for the Electronic and Telecommunication Specialization

Module Code	BM2800	**Module Title**	Introduction to Biomedical Engineering			
Credits	2.0	**Hours/Week**	**Lectures**	2	**Pre/Co-requisites**	-
GPA/NGPA	GPA		**Lab/Assignments**	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Identify different biological systems and their functions.					
2.	Construct simple engineering models for physiological systems.					
3.	Analyze engineering solutions to physiological phenomena.					
Outline Syllabus						
1.	**Overview of Biomedical Engineering (2 h):** Divisions of biomedical engineering, activities of biomedical engineers, ethical issues in biomedical engineering.					
2.	**Overview of the Human Body (8 h):** Brief description of anatomical and physiological divisions of the human body.					
3.	**Basic Principles and Concepts in Biomedical Engineering (4 h):** Review of linear systems, time and frequency domain techniques.					
4.	**Respiratory Mechanics and Mechanical Ventilation (6 h):** Models for respiratory mechanics, method of identifying abnormalities respiration, ventilators.					
5.	**Models of Cardiovascular System and Related Medical Equipment (8 h):** Chemo-reflex regulation of respiration, cardiovascular mechanics, heart-rate variability, cardiac electrophysiology, pacemakers, and defibrillators.					

Service Module Information

Following modules are offered to students from external departments

Module Code	EN1012	**Module Title**	Electronic Devices and Circuits			
Credits	2.0	**Hours/Week**	**Lectures**	2	**Pre/Co-requisites**	-
GPA/NGPA	GPA		**Lab/Assignments**	-		
Learning Outcomes						
At the end of this module the student will be able to:						
1.	Identify electrons and photons, the two particles which are important in semiconductor electronics and optoelectronics.					
2.	Design a simple DC power supply.					
3.	Design a single stage amplifier and estimate the voltage and current gains and input & output impedances of the amplifier.					
4.	Simulate a simple amplifier operation using suitable software.					
5.	Construct a digital combinational circuit to perform a simple logical operation.					
Outline Syllabus						
1.	Wave-particle duality of light and matter **(1 h)**					
2.	Energy levels and stimulated emission of radiation **(2 h)**					
3.	Schrödinger wave equation: Band theory of solids, E-k diagram, Fermi-Dirac statistics and Fermi Level **(4 h)**					
4.	Conduction in metals, Conduction in p-n junction devices, diffusion and junction capacitance of a p-n junction **(3 h)**					
5.	Diodes and their applications **(4 h)**					
6.	Transistor Amplifier; BJT and FET **(6 h)**					
7.	Logic circuits **(6 h)**					
8.	Logic families: DL, DTL, TTL **(2 h)**					

Module Code	EN1052	Module Title	Introduction to Telecommunication			
Credits	2.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Explain basic concepts related to communication systems.
2.	Differentiate between analog and digital communications principles.
3.	Describe basic aspects of a computer network.
4.	Differentiate between network topologies and types of networks.
5.	Discuss the operation of end user equipment in communications.

Outline Syllabus	
1.	**Introduction to Telecommunication Systems (2 h):** Historical developments and current trends.
2.	**Elementary Concepts in Telecommunications (6 h):** Digital and analog signals, Types of communication channels, bandwidth and filtering, the effect of bandwidth and noise on signals, the radio spectrum and wave propagation, modulation.
3.	**Transmission (4 h):** Guided and unguided transmission, multiplexing, transmission networks, multiplexing hierarchies for high speed communication networks.
4.	**Access Networks (5 h):** PSTN, DSL, Wireless local loop, Mobile.
5.	**Switching and Signaling (2 h):** Hierarchical networks, teletraffic concepts.
6.	**Networking Principles (5 h):** Topologies, types of networks, layered architecture, internetworking, security including public key encryption.
7.	**Telecommunication Devices (4 h):** Telephone instruments, radio receivers, TV receivers, Modems, cellular phones etc.

Module Code	EN1802	Module Title	Basic Electronics			
Credits	2.0	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/4		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Describe basic principles of operation of semiconductor devices
2.	Use diodes and transistors in simple electronic circuits
3.	Use operational amplifiers in simple amplifier applications
4.	Use logic gates to design simple combinational logic circuits.

Outline Syllabus	
1.	**Introduction (2 h):** Historical aspects, practical electronic systems, electronic industry, practical aspects of passive components, manufacturing electronic products, software tools.
2.	**Materials Used in Electronics (2 h):** Introduction to semiconductors and their basic properties, modern electronic materials.
3.	**Diodes, Diode Circuits and Applications (4 h):** Operation and characteristics of junction diode, zener diode, varactor diode and light emitting diode, rectification, clamping and limiting circuits, thyristors and controlled rectification.
4.	**Bipolar Junction Transistors (BJTs) and Circuits (4 h):** Operation and characteristics of BJT, use as a switch and as an amplifier, biasing schemes, amplifier configurations and parameters.
5.	**Field Effect Transistors (FETs) and Circuits (4 h):** Operation and characteristics of JFET, use as a switch and as an amplifier, comparison with BJTs.
6.	**Integrated Circuit Amplifiers (4 h):** The need for integration, operational amplifiers, inverting amplifier configuration of op amp, monolithic audio IC amplifiers.
7	**Logic Gates and Circuits (8 h):** Logic gates and Boolean algebra, minimization of logic expressions, combinational logic circuits, introduction to sequential logic circuits, design of simple logic circuits.

Module Code	EN2012	Module Title	Analog Electronics			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Examine the behavior of BJT and FET amplifiers in low, mid and high frequency ranges.
2.	Design transistor amplifiers to meet given specifications.
3.	Explain the differential amplifying concepts.
4.	Identify the functionality and applications of operational amplifier circuits.
5.	Identify different power amplifier classes and their characteristics.
6.	Perform power calculations for power amplifiers.
7.	Identify power electronic devices, their construction, operation and applications.

Outline Syllabus	
1.	**Analysis of Transistor Circuits (12 h):** DC analysis of transistor circuits, biasing circuits for BJTs and FETs, transistor as an amplifier, single-stage BJT/FET amplifier configurations, small-signal models, small signal mid-frequency equivalent circuits and analysis, low frequency and high frequency equivalent circuits of BJT/FET circuits, h-parameter model, pole zero analysis, Bode plots, frequency response of amplifiers, multistage amplifiers.
2.	**Differential Amplifiers (2 h):** The BJT differential pair, small-signal operation of the BJT differential amplifier, characteristics of a differential amplifier, differential amplifier with active load.
3.	**Operational Amplifiers (6 h):** Ideal op amp, negative feedback in op amp circuits, op amp specifications, op amp applications, practical behavior of op amps, instrumentation amplifiers.
4.	**Power Amplifiers (4 h):** Definitions, applications and types of power amplifiers, power transistors, transistor power dissipation, amplifier classes and their efficiency, push-pull amplifiers, harmonic distortion and feedback, heat generation of power transistors and heat sinks.
5.	**Power Electronic Devices and Circuits (4 h):** Properties and applications of thyristors, triacs, diacs, uni-junction transistors, power MOSFETs, IGBTs and GTOs, power electronic circuits such as power controllers, CDI, protection and switching circuits.

Module Code	EN2022	Module Title	Digital Electronics			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Design combinational and sequential digital circuits.
2.	Differentiate characteristics of logic families.
3.	Compare usage of different logic families.
4.	Use programmable devices in digital circuits.
5.	Compare different types of analog-to-digital and digital-to-analog converters.

Outline Syllabus	
1.	**Combinational and Sequential Logic Circuits (12 h):** Five variable Karnaugh maps, Quine–McCluskey method, flip-flops, latches, counters, registers and other MSI devices, design of finite state machines.
2.	**Logic Families (6 h):** Ideal logic gates, logic levels and noise margins, dynamic response of logic gates, analysis of logic families (fan-in, fan-out), diode logic, logic families (DTL, TTL, ECL, CMOS).
3.	**Programmable Devices (8 h):** Programmable logic devices, PLAs, PALs, GALs, RAM and ROM chips, microcontrollers.
4.	**Conversion Circuits (2 h):** ADC, DAC, types dual slope, successive approximation etc., common chips available.

Module Code	EN2852	Module Title	Applied Electronics			
Credits	2.0	Hours/Week	Lectures	1.5	Pre/Co-requisites	
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Identify characteristics of operational amplifiers.
2.	Use operational amplifiers in simple applications.
3.	Identify different types of sensors and their operation.
4.	Use sensors in simple applications.
5.	Use data converters in simple applications.

Outline Syllabus	
1.	**Operational Amplifiers (8 h):** Operation and characteristics, non-inverting and inverting configuration, applications: inverter, comparator, voltage follower (buffer), adder, subtractor, integrator, differentiator, oscillator.
2.	**Sensors and Transducers (8 h):** Performance characteristics of transducers: dynamic range, sensitivity, resolution, input/output impedance, useful frequency range, resistance transducers, opto-conductive transducers, capacitive transducers, inductive transducers, thermocouples, piezoelectric transducers.
3.	**Electronic Instrumentation Systems (8 h):** Analog-to-digital and digital-to-analog conversion, frequency ranges and bandwidth, signal reflection in cables, noise and interference, noise reduction methods.
4.	**Microcontrollers (4 h):** Introduction, programming and applications of microcontrollers.

Module Code	EN2062	Module Title	Signals and Systems			
Credits	2.5	Hours/Week	Lectures	2	Pre/Co-requisites	-
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes	
At the end of this module the student will be able to:	
1.	Formulate time and frequency domain descriptions for basic continuous and discrete time signals.
2.	Analyze linear time invariant continuous and discrete time systems based on system characteristics.
3.	Analyze simple systems to determine their stability and response to various input signals.
4.	Use software as an analysis tool to investigate the operation of LTI systems.

Outline Syllabus	
1.	**Introduction to Signals and Systems (4 h):** Continuous and discrete signal models, building block signals (e.g., pulse, impulse etc.), energy and power signals, use of software tools to represent signals, continuous and discrete system modeling using block diagrams, continuous and discrete system classification (e.g., causal/non causal, linear/ nonlinear).
2.	**Linear Time Invariant Systems (6 h):** Continuous and discrete time impulse, impulse response and convolution, differential and difference equation system representations, software tools for discrete and continuous time system analysis.
3.	**Frequency Domain Analysis Methods (14 h):** Continuous and discrete time frequency response characteristics, Fourier series representation of periodic signals, properties of continuous and discrete time Fourier series, applications of Fourier series for power supply design, continuous time Fourier transform, discrete time Fourier transform, properties and applications of Fourier transforms, sampling and reconstruction, Laplace transforms and z-transforms.
4.	**Stability Analysis (4 h):** Stability analysis of discrete and continuous time systems, pole-zero analysis of systems, BIBO stability.

Academic Standards and Administrative Processes for Students

Beginning-of-academic-year checklist

- √ Renew library registration.
- √ Pay registration and examination fees to the finance division.
- √ Update the student record book at the examinations division.

Beginning-of-semester checklist

- √ Select appropriate subjects for the semester according to the credit requirement
  - Check pre-requisites.
  - Check departmental GPA credit requirement.
  - Check non-departmental GPA credit requirement.
  - Check Non-GPA credit requirement.
- √ Register at LearnOrg for the selected subjects: lms.mrt.ac.lk
- √ Verify the accuracy of the confirmation form and submit to undergraduate studies division.
- √ Add/drop subjects within 2 weeks from the start of semester and finalize the semester subject selection.
- √ Collect previous semester results sheets from the examinations division.

Training (Internship)

- √ Search for possible training opportunities during level 3 semester 1
- √ Once an establishment is finalized document the necessary contract provided by NAITA
- √ After commencement of training, send a one page report of progress update to the training division once a month.
- √ Update the training diary regularly and keep it ready for inspection.
- √ Submit the training report after successful completion of the training.
- √ After completion of viva exams consult the training division to find out when the training certificate can be obtained.

Semester Coordinators

Semester 2:
Dr. Ranga Rodrigo
Semester 3:
Dr. Tharaka Samarasinghe
Semester 4:
Dr. Jayathu Samarawickrama
Semester 5:
Dr. Chamira Edussooriya
Semester 6:
Dr. Peshala Jayasekara
Semester 7:
Dr. Mevan Gunawardena
Semester 8:
Dr. Anjula De Silva

Graduation Checklist

Graduation Checklist	In case of an issue contact:
√ Verify whether the credit requirement for graduation is complete.	Director/ Undergraduate Studies Ext: 3051
√ Collect all the official results sheets from the examinations division.	SAR/ Examinations Ext: 1401
√ Complete departmental clearance form and hand it over to the head of the department.	Head of the Department Ext: 3301
√ Obtain and hand over the duly completed transcript application form to the examinations division along with necessary payments for the transcripts.	SAR/ Examinations Ext: 1401
√ Collect the original birth certificate and the school leaving certificate from the examinations division along with the transcript.	SAR/ Examinations Ext: 1401
√ Await convocation instructions and invitations by mail and collect the cloaks as advised.	SAR/ Examinations Ext: 1401
√ Produce the cloak returned slip along with proof of due payments, (if any) and collect the degree certificate.	SAR/ Examinations Ext: 1401

Research at ENTC

Research is any activity directed at finding solutions for unsolved problems in a global context or exploring an area which has not been looked at before. Such activities require dedication and commitment which strengthens one's ability to do independent work. Thus, research is an important component of undergraduate education. The department has created a vibrant research culture, and you have an opportunity to engage in research projects from the inception of semester 2.

The department has five active research groups on Communications, Intelligent Systems, Machine Vision, Biomedical Engineering and Reconfigurable Digital Systems. Additionally, the department heavily promotes agricultural electronics based projects to improve the overall productivity of the agriculture sector. You are strongly encouraged to get involved with any of these research activities ccording to your interests. It is quite acceptable to work with different groups until you find the best match. You will find such work both stimulating and rewarding and you will undoubtedly realize that such an effort has a definite positive impact on your academic progress. Please refer to the research group web pages to see the latest information. During the final year, you will get an opportunity to engage in a research project spanning the entire year that gives academic credit.

Communication Research Group

The evolution towards ubiquitous (anytime, anywhere) communications and computing poses problems requiring novel ways of utilizing the frequency spectrum and the wireless channel. The group's focus is on these aspects

Ongoing Projects:

1. Modelling of optical carrier recovery and phase synchronization scheme. Current optical fiber communication systems are deviating from intensity modulated transmission schemes to phase modulated transmission schemes due to various reasons such as impairment mitigation, data rate increment, etc. Therefore, this research focuses on extracting phase information from a degraded phase modulated signal, which will be useful in optical detection and regeneration schemes. This research is funded by National Research Council (NRC) research grants.

2. Polarization Insensitive, Phase sensitive amplifier for phase Regeneration - New standards have been released recently for increasing the data rates used in optical fiber core and metro networks operating at 100 Gbps. Basically 100 Gbps systems employ DP-QPSK schemes and in some of the 40 Gbps optical networks are operating in (D) PSK/QPSK schemes.

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3. Insensitive, Phase sensitive amplifier for phase Regeneration - New standards have been released recently for increasing the data rates used in optical fiber core and metro networks operating at 100 Gbps. Basically 100 Gbps systems employ DP-QPSK schemes and in some of the 40 Gbps optical networks are operating in (D)PSK/QPSK schemes. Therefore, this research focuses on optical regenerating schemes which is capable of regenerating both amplitude and phase of a degraded phase modulated signal. This research is funded by National Research Council (NRC) research grants.

4. Hybrid cellular-networks -The low penetration of on-board devices supporting Vehicle-to-vehicle (V2V) communications hinders many possible applications in intelligent transportation systems. The research focuses on using communication capabilities of mobile phones to facilitate the process, and design low cost on-board units with much of the V2V communications processing handed over to the mobile phone. This research is funded by Senate Research Committee (SRC) long and medium term grants.

5. The detection of signals in noisy observations is one of the fundamental problems in statistical signal processing. This problem also arises in various other scientific disciplines such as radar, sonar, wireless communications and finance. In its most basic form, the presence of a signal amounts to rank one departure of the population covariance matrix from the identity. Equivalently, the largest eigenvalue of the population covariance matrix deviates from unity. Since we do not have access to the population covariance matrix, we focus on the largest eigenvalue of the sample covariance matrix (i.e., signal plus noise) formed with the noisy observations (say S). Moreover, if the noise co-variance matrix is unknown, then it is common to construct another sample covariance matrix from noise only observations (say R). Then it is natural to consider the behavior of the largest eigenvalue of $F = R^{-1}S$ in order to infer the presence of a signal. Therefore, the main objective of this project is to investigate the asymptotic (i.e., high dimensional) behavior of the largest eigenvalue of F matrix when R and S are Wishart distributed.

Members:
Prof. Dileeka Dias
Eng. Kithsiri Samarasinghe
Prof. Ruwan Weerasooriya
Dr. Prathapasinghe Dharmawansa
Dr. Chathuranga Weeraddana
Dr. Tharaka Samarasinghe
Dr. Kasun Hemachandra

Web: http://www.ent.mrt.ac.lk/crg

Intelligent Systems Research Group

Intelligent Systems Research Group (ISRG) engages in designing intelligent systems and their deployment in real-world applications. The target areas of ISRG are robotics, drones, control systems, teleoperation, visual servoing, and AI.

Ongoing Projects:

1. "**Hornet**", the Vertical Take-off and Landing (VToL) winged drone project, funded by the National Research Council is nearing its successful completion. Hornet uses four vertical vertical thrusters in quadrotor

configuration together with a horizontal pusher propeller. The four vertical thrusters are used to take off and land vertically, and the horizontal pusher propeller is used for cruise flying during the mission using wings. Hornet does not need a runway and it has long endurance due to winged flight in the mission.

2. "**Quad²**" is a four quadrotors in a quadrotor assembly. This novel design gives redundancy and robustness in view of actuator failures while reducing Electromagnetic Interference from the Electronic Speed Conrollers and brushless DC motors on the electronic sensor system. Quad² is funded by the Senate Research Committee

3. **Drone Based Agriculture** project is now underway in which a drone is used for aerial monitoring of the green complexion of paddy over the season and clinically advise the farmer the best curse of actions to improve the yield.

4. **Autonomous Drone Landing**, and package delivery using drones are also being tested as final year projects.

5. **Vision Based Traffic Monitoring** project is successfully reaching its goal. In this project, photos taken are processed in realtime and determine the road occupancy using a trained neural network. Experiments conducted recently have given accurate results for implementation of the method for traffic control where the present static timing can be dynamically altered using vision-based traffic information.

6. **Underwater Robotics**: An underwater robot and its mother vehicle on water surface have been built recently with the intention of investigating underwater infrastructures such as dams and bridges. Initial tests of controllability, stability and appropriateness of these two vehicles have been already verified through tests in Bolgoda lake. At present, the communications between the two vehicles have been replaced with an underwater navigation link, with which new navigation algorithms will be developed. These algorithms will ensure that the untethered underwater vehicle stay close with the surface vehicle and perform the underwater task properly.

7. **A Solar-powered Autonomous Robotic Surface Vessel** for aquatic surveillance and monitoring has been initiated. This work is expected to address several key issues including the increase in the number of illegal fishermen approaching Sri Lankan territory and the increase in illegal activities on local water bodies such as sand mining, garbage dumping and toxic material disposal.

8. **Disaster Response**: A semi-autonomous legged robot platform for disaster response related mapping, localization and search for victims using thermal camera has been initiated. The legged locomotion mechanism helps navigation on rough and challenging outdoor terrain in the event of natural disasters. Furthermore, a micro unmanned aerial vehicle (UAV) using sparse sensing technologies has been introduced to locate buried victims in an indoor collapsed building environment. The main focus in this project is to locate victims in a short period of time with minimal sensing.

Members:
Prof. Rohan Munasinghe
Dr. Jayathu Samarawickrama
Dr. Peshala Jayasekara

Labs:
Intelligent Machines Laboratory
Unmanned Aerial Vehicle Research Laboratory
Underwater Vehicles Research Laboratory

Web: http://www.ent.mrt.ac.lk/research/isrg

Machine Vision Research Group

Making the computer see, as a human being would, is the goal of machine vision. This 40-year-old field of research has seen many success stories such as face detection in cameras, optical character recognition for checks, fingerprint matching, human-level object detection, autonomous desert driving, and breathtaking visual effects such as fly-around in the movie industry. However, the general computer vision problem is far from being solved. There are many areas which need substantial amount of work to be usefully changing the way we work. For example, autonomous urban driving using visual navigation, human behavior identification for surveillance and helping the elderly, combing visual recognition with other forms of information such as text, registering a tumor for image guided surgery and many other problems are far from being solved or need improved solutions. There is, then, much work to be done to make the machines see as we do. Machine Vision Group attempts to solve several such problems.

1.Context-Aware Occlusion Removal
In this work, we identify objects that do not relate to the image context as occlusions and remove them, reconstructing the space occupied coherently. We detect occlusions by considering the relation between foreground and background object classes represented by vector embeddings, and removes them through inpainting. We use deep networks for semantic segmentation, and word embeddings generated by the word-to-vector model in this work.

2. Extensions to Capsule Networks
We extended the recent capsule networks model, a deep neural network that better models hierarchical relationships, taking several paths. In the TextCaps work, we adjust the instantiation parameters with random controlled noise to generate new training samples from the existing samples, with realistic augmentations which reflect actual variations that are present in human hand writing. Our results with a mere 200 training samples per class surpass existing character recognition results in MNIST and several other datasets. In DeepCaps, we developed a deep capsule network architecture which uses a novel 3D convolution based dynamic routing algorithm. Further, we propose a class-independent decoder network, which strengthens the use of reconstruction loss as a regularization term. This leads to an interesting property of the decoder, which allows us to identify and control the physical attributes of the images represented by the instantiation parameters.

3. Gait Analysis
There are several systems that use one or several Kinect sensors for human gait analysis, particularly for diagnosis of patients. However, due to the limited depth sensing range of the Kinect---a sensor manufactured for video gaming---the depth measurement accuracy reduces with distance from the Kinect. In addition, self-occlusion of the subject limits the accuracy and utility of such systems. We overcome these limitations by first by using a two-Kinect gait analysis system and second by mechanically moving the Kinects in synchronization with the test subject and each other. These methods increase the practical measurement range of the Kinect based system whilst maintaining the measurement accuracy.

4. Vision Processor Design
The widespread use of high definition cameras for surveillance and related tasks has given rise to the concept of edge computing as transmitting and processing video streams in real time have become challenging. However, edge computing at low power and lower cost is difficult with general purpose processor hardware inside cameras. Finding a solution that meets the above requirements and demonstrate flexibility to handle diverse conditions is challenging. We design processors geared for com

puter vision tasks to overcome this challenge.

Some of the above research projects were funded by the National Research Council, National Science Foundation, and Senate Research Committee of the University of Moratwua.

Members:
Dr. Ranga Rodrigo
Dr. Ajith Pasqual
Dr. Nuwan Dayananda
Dr. Jayathu Samarawickrama
Dr. Chamira Edussooriya

Web: http://www.ent.mrt.ac.lk/mvg http://www.ent.mrt.ac.lk/~ranga/research.php

Biomedical Research Group

1. Gait Analysis using Inertial Measurement Units (IMU) sensors
This project continues on the success of the 2D gait analysis system developed in 2014 to capture the 3D motion in lower limb movement using IMU sensors. This system will be useful for clinicians to identify deviations from normal walking patterns and measure changes that are important from a rehabilitation point of view.

2. Upper Limb Motion Analysis Using Inertial Measurement Units (IMU) sensors
This project aims to develop a system for analyzing upper limb movement using IMU sensors that will enable cricket coaches to analyse bowling actions of players and detect illegal actions.

3. Objective Measurement of Immersion in AR/VR using Electroencephalogram (EEG)
Immersion is a measurement of the effectiveness of an AR/VR system as experienced by the user. This research project proposes a method to quantitatively measure immersion using EEG and analyses its feasibility. The proposed method consists of 4 components. First, EEG is used to obtain the mental state of users. Secondly, the relationship between these mental states and immersion is investigated. Thirdly, a model combining the first two stages is built. Finally this model is validated.

4. Development of a Tool for Analyzing Foot Biomechanics and Personalized Care
This project is funded by a Senate Research Committee(SRC) grant and aims to develop a tool for analyzing the biomechanics of the foot based on 3D, geometrically accurate models based on medical image data and finite element analysis to understand the internal stress state, in order to offer a personalized solution for better foot care.

5. Correlation of the Endothelial Function for Early Prediction of Vascular Diseases
Vascular diseases are mainly caused by the disfunctionality of the endothelium which is the inner most layer of blood vessels. This project investigates instrumentation development and verification of novel parameters including bioimpedance which reflects this dysfunctionality of the endothelium

6. Modelling of the Human Ejaculatory Ducts
The standard treatment for benign prostatic hyperplasia is transurethral resection of the prostate. The accuracy of this surgery can be enhanced by 3D modeling.The steps of duct modelling are: Image registration, segmentation and modelling. The transformation is calculated manually and intensity based rigid registration is used to register the captured cadaver images. An active contour model is then used to segment the prostate. A novel segmentation approach is under development with an enormous morphological challenge at hand.

7. Hearing Screening Through Auditory Evoked Potentials
Auditory neuropathy cannot be diagnosed through traditional hearing tests. Therefore, an evoked potential based method is used

to assess hearing objectively. This project looks at developing a device for auditory stimulus delivery, data acquisition, data processing and decision making.

8. An Augmented Reality Surgical Simulator for Laparoscopic Choleycystectomy
Surgical simulators without force feedback do not give the user the real experience they get during laparoscopic procedures. Through this project, we model the top-tissue interaction forces and simulate haptic feedback added to the surgical simulator.

Members:
Dr. Nuwan Dayananda
Dr. Anjula de Silva
Dr. Pujitha Silva

Web: http://www.ent.mrt.ac.lk/bme

Reconfigurable Digital Systems Research Group

The group focuses on three areas:

(a) Development of novel architectures for application specific processors in the area of networking, machine vision, video processing and machine learning.

(b) Efficient on-chip implementation of advanced algorithms that can exploit massive parallelism available at hardware level. Development of IP Cores, which can be considered as building blocks for complex System on Chip (SoC) is given top priority.

(c) Development of RISC-V processor on FPGA to be a plug-in replacement for Xilinx and Intel soft-processors.

Ongoing projects:

1. Application specific processors for machine vision, video processing and networking.
2. Neural Network Accelerators on FPGA.
3. RISC-V Processor development on FPGA.
4. FPGA architectures for uncompressed professional video transport over IP networks.

Members:
Dr. Ajith Pasqual
Dr. Jayathu Samarawickrama
Dr. S. Thayaparan

Web: http://www.ent.mrt.ac.lk/rds

Postgraduate Taught Degrees

PG Dip/M.Sc in Electronics and Automation

This program has been especially designed to target practicing engineers in electronic and automation industries, in electronics, electronics technology and automation industry who wish to build and advance their careers in these fast-changing and challenging fields of study. This is a two year part-time degree program. The first year (3 semesters of 14 weeks each) consists of lectures conducted on weekends.
Web: www.ent.mrt.ac.lk/web/pg/ea

PG Dip/MSc n Telecommunications

This course has been developed specifically targeting engineers who wish to build and advance their careers in this fast-changing and challenging field of study. This is a two-year part-time degree program. The first year consists of lectures conducted on one weekday evening and weekends. The first year consists of 3 emesters, and candidates are expected to earn the required number of credits from the core and optional course modules during this period.

Web :
http://www.ent.mrt.ac.lk/msc-telecom

E-Club

The E-Club is the official student association of the Department of Electronic and Telecommunication Engineering, University of Moratuwa. The club mainly focuses on creating competent and socially responsible electronic and telecommunication engineers for the country.

The Electronics Club, now commonly known as the E-Club was established two decades ago, and has gone from strength to strength over the years. Its vision is "serving humanity through electronics".

Objectives of the E-Club

- Acting as a platform, where interaction between undergraduates and the industry is highly enabled, while exposing innovative and creative thinking capacity of undergraduates to the industry.
- Identifying current trends, technological development in the electronic and telecommunication industry and facilitating undergraduates to acquire necessary skills, and shaping their attitudes to become successful professional engineers.
- Contributing to the enhancement of the living standards of the under privileged segments in the society.

Activities of the E-Club

A variety of activities are carried out by the E-Club, with the above objectives in mind while providing a platform for the undergraduates to develop their careers.

Undergraduate-Industry Interaction Activities

Specialists in the fields of technology and management are invited to share their knowledge and experience with the undergraduates and to provide their advice. Through these sessions the undergraduates are motivated to be aware of the industry expectations, so that the undergraduates can get prepared to fit into the world of work.

Workshops and Seminars

Consultants and project planners are invited periodically to hold workshops to give a picture of the role to be played by an engineer. Moreover, this provides a chance for our students to learn to interact and exchange ideas without hesitation and to learn to accept the views of experienced people. This event is also used to invite experts to present a new technology introduced in the country, so that students are made aware of the current trend.

E-Forum

E-forum is a common platform for the undergraduates, faculty, industry, government and other relevant institutes to discuss the common challenges faced by the fields of electronics and telecommunications. This caters to the requirements of gearing up to lead national development, exposing the skills and talents of undergraduates, strengthening the relationship with the industry, and creating awareness about the industry. The forum helps in sharing knowledge and experience in relevant fields of engineering, discussing the trends and new opportunities emerging in the outside industry, presenting final year projects, and recognizing the excellence of the undergraduates.

“Tronic” Premier League (TPL)
The most awaited sports extravaganza of the department, TPL, is held annually at the university grounds with the ENTC family. TPL is a friendly cricket encounter between all three batches of the department and the academic staff. The purpose of this event is to enhance the bond among department students while giving them the opportunity to enjoy life at the university.

“Tronic” Shuttle Fest
This badminton tournament is a novel event introduced to the event calendar of the E-Club since 2014 with the motive of developing the sportsmanship and soft skills of the engineering undergraduates in the department. Sports have been identified as a major factor that could help create a balanced personality.

Community Service Projects(CSR)
E-Care, the department’s main CSR activity is about helping the students in a school that can benefit from the knowledge and skills of university students. It is a fun-filled and educational encounter for both the undergraduates and the school students. Donating books, repairing computers, painting the school and sharing a meal are all part of the E-Care program.

Sri Lanka Robotics Challenge
The University of Moratuwa, being the country’s leading technological higher education institute, has been monumental in popularizing cutting-edge technology. This event is a gateway for all those interested in robotics and automation to unleash their talents in the field to a much versed audience and also in itself a gathering for the tech savy youth to enhance their knowledge and gain outright experience. Alongside with the Department of Electronic and Telecommunication Engineering, It has been a key partner in organizing the Zonal Competition of the International Robotics Challenge (IRC), which is conducted as a part of the biggest Technology Festival of India, “TechFest” .

Athwala - Pay it Forward
This is a scholarship scheme initiated by the Electronic Club starting from this year onwards with the intention of providing financial aid exclusively for the undergraduates of the department who are in need. The benefactors of the funds would be the ENTC Alumni who have eagerly joined hands with the E-Club for this noble cause.

Through this initiation, the E-Club expects that the financial barriers will not limit the odyssey beyond excellence of our undergraduates. Athwala will help the brilliant minds of the department to perform better in their academic career while engaging in extra-curricular activities.

This brings out another perspective for the brotherhood of the ENTC family by enhancing the friendship between the ENTC Alumni and the present undergraduates. We at E-Club, believe that the future generations will understand the duty towards their alma-mater through this project.

Student Awards

Gold Medal donated by the Ceylon Electricity Board

Awarded to the electronic and telecommunication engineering graduate who has obtained the highest overall grade point average of 3.8 or above at the B.Sc. Engineering degree examinations.

Gold Medal donated by Technomedics International (Pvt) Ltd.

Awarded to the biomedical engineering graduate who has obtained the highest overall grade point average of 3.8 or above at the B.Sc. Engineering degree examinations.

Prof. O.P. Kulashethra Award

For electrical engineering, or electronic and telecommunication engineering graduate who has obtained the highest grade point average of 3.7 or above, computed by taking into consideration grades obtained for courses conducted by the electrical engineering, and electronics & telecommunication engineering departments in the B.Sc. Engineering degree course at level 2, 3, and 4.

Sri Lanka Telecom Scholarship

For the B.Sc. level 4 student in electronic & telecommunication engineering who has obtained the highest grade point average of 3.7 or above considering all subjects offered at level 2 and 3.

Prof. K.K.Y.W. Perera Award

Electronic & telecommunication engineering graduate who has obtained the highest grade point average of 3.7 or above considering all subjects offered at level 4.

Vidya Jyothi Professor Dayantha S Wijeyesekera Award

Awarded for the most outstanding graduate of the year who is a versatile graduate of the University of Moratuwa of proven academic standing with a GPA exceeding 3.7 (or First Class honours); who has been recognized as a leader and held in high esteem by other students; and has made a significant contribution through participation and service to the university and community.

Manamperi Award - Sri Lanka Association for the Advancement of Science

Awarded annually to the best undergraduate research engineering project carried out at a faculty of engineering in a Sri Lankan university. This award is open to students who have submitted their undergraduate engineering project to a Sri Lankan university within the academic year in consideration. A duly completed application along with a project report not exceeding 1500 words should be submitted to the SLAAS by the students themselves who wish to qualify for this award.

Migara Ranatunga Trust Award

This is awarded to the high achievers of level 3 industrial training module at the Annual sessions of IESL. The results of the evaluations done by the university training division will be submitted to the IESL, where a few undergraduates would be recognized as high achievers in the compulsory industrial training module in the engineering undergraduate program.

Leadership, Scholarship and Service (LSS) Award

LSS award is given to final year undergraduates specializing in Electronic & Telecommunication Engineering. Exemplary character, responsible leadership, service in campus or community life, superior scholarship and intelligence, genuine fellowship, and loyalty to democratic ideals are indispensable qualifications for the LSS award. The award winners will belong to the 'LSS honour Society'. Membership of the 'LSS honour society' will be a mark of the highest distinction. Award winners are selected on the basis of merit.

Student Recommendation Criteria

It is the student's responsibility to engage in the activities given below and the staff is aware of such engagements so that recommendation requests will be viewed positively.

Please note that it is not a right of the student to receive a recommendation but a privilege afforded to them by the staff of the department.

The main focus of the department of Electronic and Telecommunicaion Engineering is and always has been to produce well balanced Engineers, encouraging students to actively engage in constructive extracurricular activities amidst excelling in academics. Some of those extracurricular endeavors are even treated as traditions in the department and has become an integral part of the student life at the department. These ultimately differentiated a graduate from our department as a unique individual among others.

Recommendation Criteria

- Active participation in the events organized by the E-Club such as E-Care, E-Forum and Expose exhibition
- Active participation as a committee member of the Expose exhibition
- Proper maintenance and administration of the final year projects handed down from the previous batches to be presented at the department
- Voluntary community work outside the university with valid commendations
- Taking up duties as the field representative
- Serving as a visiting instructor during the final year of undergraduate studies
- Serving as a visiting instructor for short courses and training programs
- Representing the department in the inter-department sports activities
- Involvement in voluntary undergraduate projects with staff members
- Supporting staff in extracurricular activities that bring reputation to the department
- Active support for workshops, symposiums and seminars conducted by the department and university support staff in extracurricular activities that bring reputation to the department
- Participating in exhibition stalls representing the department
- Beneficial interaction with the industry
- Student publications in peer reviewed conferences and other research related publications
- Representing the department in prestigious national and international level competitions

Web Sites

LearnOrg and Moodle

This is a student academic administration system which primarily maintains student records and provides access to students as well as to the staff. At present the system allows students to register for new modules and manage the modules by providing Add/Drop facilities. ***Web: lms.mrt.ac.lk***

Moodle is a course management system through which distribution and submission of continuous assessments is done for courses. It is integrated with LearnOrg for authentication and enrolments. It gives students the experience of e-learning which in fact is the current trend in university education around the world. ***Web: online.mrt.ac.lk***

Webmail

ENTC Webmail System offers all registered students (undergraduate and postgraduate), technical and administrative staff as well as the academic staff a secure and convenient way of accessing their e-mails from anywhere in the world. It acts as the primary interface of information exchange with the outside environment to both ENTC students and the staff. ***Web: www.ent.mrt.ac.lk/webmail***

Alumni Support

The alumni of the Department of Electronic and Telecommunication Engineering give their time, talent, and support to the department.The alumni engages with the department officially, through their respective organizations, and in personal capacity.

Official engagement of the alumni with the department is through the Department Industry Consultative Board (DICB). At the DICB meeting, the alumni offers suggestions for making the curriculum industry-relevant. Some have contributed being invited members of the Faculty of Engineering, and even at the University Council.

The alumni makes its wealth of experience and industry expertise freely available to the students through guest lectures. Current topics, special technical topics not in the curriculum, getting ready to face the challenges in the industry, and higher studies are some of the themes these talks addressed in the past. Along with the lectures, the alumni makes sure to bring support from their respective organizations to the students and the department. This is beneficial to the students, the department, and the organizations.

Support given to the department in the personal capacity of the alumni, particularly as batches of each year, is significant.

Alumni Support

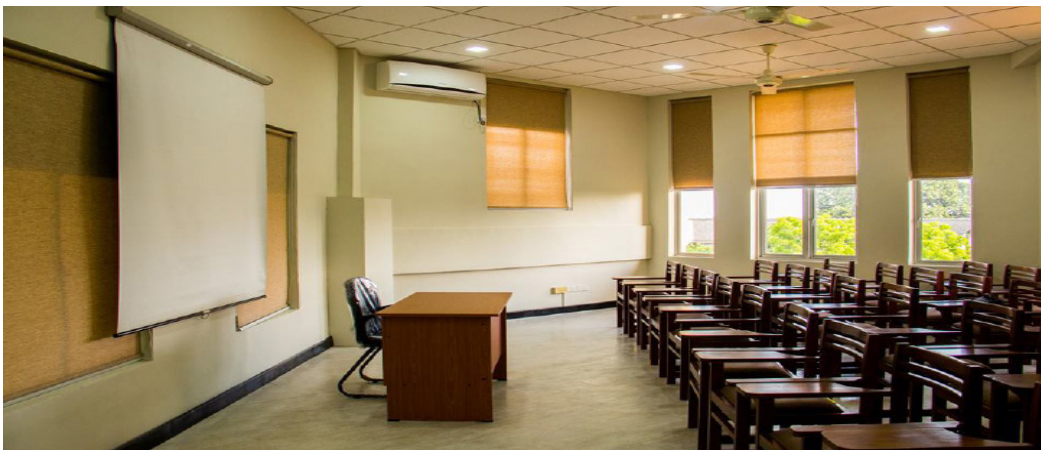
Some facilities that our students enjoy are donations from the alumni. For example, the batch that entered in 2002 made the main lecture hall, ENTC1, air-conditioned and decorated it with curtains.The batch that entered in 2003 provided curtains to the analog and digital electronic laboratories. The alumni in the batch that joined in 2004 made the wooden stage in ENTC1.

The furniture and curtains in the conference room are from the batch that entered in 2005. Following the same path as their seniors, the batch that entered in 2006 fitted the PG seminar room with curtains to solve the long-standing problem of poor visibility of the writing boards.

Students of the batches that entered in 2008 and 2009 fully funded the refurbishment and air-conditioning of the two modern classrooms located on the topmost floor of the department.

The department is grateful to the generous alumni. The alumni frequents the department whenever there is a special function or a sports event. The head of the department invites the alumni to maintain this close relationship, which greatly benefits the department and the students. Thank you for the generous support.

If you wish to re-connect with the department or contribute, please contact the head of the department via head-entc@uom.lk



Achievements of ENTC Students

Industrial Application Society (IAS) Myron Zucker 2017

The students of the Department of Electronic and Telecommunication Engineering, continued to display dominance in the robotics arena for the past few years. The Myron Zucker undergraduate student contest is an international robotic competition organized by IEEE Industrial Application Society (IAS) for all IEEE undergraduate students around the world. Jathushan Rajasekaram from ENTC represented Sri Lanka at the Myron Zucker Students Design Contest in 2017 and emerged victorious while Vinoj Jayasundara secured the second place in the Myron Zucker Students Robotics Demonstration Contest in 2017.

International Robotics Challenge (IRC) 2016

The International Robotics Challenge (IRC) organized by IIT Bombay, is an annual robotics competition open to all undergraduate students.

University of Moratuwa team named "RAZOR" secured the runners-up at IRC 2016. The winning team composed of Lochana Mendis, Vinoj Jayasundara, Nuwan Tharaka, Thileapan Beniel and Supun Madusanka.

Sri Lanka Robotics Challenge (SLRC) 2017

Sri Lanka Robotics Challenge (SLRC) organized by University of Moratuwa, is one of the highly recognized robotics competitions in Sri Lanka. The University of Moratuwa team was able to secure the first place in the 2017 competition. The winning team comprised of Kithmin Wickramasinghe, Govindu Dilshan, Samith Ashan, Hiran Perera, and Iresh Jayawardana.

The same team was selected for the finals in Student Robotics Demonstration Contest 2018 organized by IEEE Industrial Application Society (IAS), which is to be held in September 2018 at Portland, USA.

Competitions Available for ENTC Students

IEEE Maker Fair 2017

A team from the University of Moratuwa was able to emerge victorious in IEEE Maker Fair 2017 held at Vardaman college of engineering, Hydrabad, India, for their exhibit “Life Saving Drone”. For this competition more than 100 teams from 10 countries including India, Nepal and Malaysia participated. The winning team comprised of Insaf Ismath, Janith Kalpa, Ama Kalpani and Samith Ashan.

Google I/O Extended Sri Lanka 2017

Google I/O Extended Sri Lanka, organized parallel to the Google I/O annual conference, was held in May 2017. The ENTC team, comprised of Insaf Ismath, Tharindu Suraj and Samith Ashan, secured the 1st Runners-up in the Chromium Collision Battle of the Bots competition hosted by Dialog and Ideamart.

IESL RoboGames

The Institution of Engineers, Sri Lanka, in its efforts to promote Engineering, Science and Technology, organizes the annual Robotic competition which will be held during the National Engineering Exhibition “Techno”. This is held under the categories of Junior, Undergraduate, Senior and Professional levels.

Web: www.iesl.lk/robogames

Techfest iNexus

Techfest iNexus is a platform for the world’s best in robotics to perform at one stage, one level and for one prize, to be crowned as the best in the world in collaboration with the annual Techfest exhibition held at IIT Bombay. iNexus became the world’s first college festival to breach its country’s boundaries and hold a truly international college robotics competition. In its maiden year the University of Moratuwa had the honor of hosting the Techfest iNexus competition. The competition is open to both undergraduate and graduate students, and conducted on a theme presented uniquely each year.

Web: www.techfest.org

Robot Design and Competition

This event is organized by the Department of Electronic and Telecommunication Engineering under the guidance of Prof. Rohan Munasinghe as a part of the elective credit course EN2532 Robot Design and Competition, where students are required to build a robot to achieve a given task. This is an internal event open only to the students of the ICT batch. ***Web: www.ent.mrt.ac.lk/~rohan/teaching/EN2060/***

IESL- UIY

Undergraduate Inventor of the Year is a competition held annually, sponsored by IESL. There are three main purposes of this competition. Those are

- to encourage and stimulate interest in undergraduate invention in the field of engineering,
- to provide and opportunity for engineering undergraduates to organize and present their original inventions both orally and via a poster
- to provide venue for networking within Sri Lanka engineering undergraduates as well as members of industry and academia.

Web: www. iesl.lk/IESL UIY

Mofilms Competition (Sri Lanka Telecom Mobitel)

MOFILMS are short films typically dedicated to raising awareness of current social issues in a fast paced, informative, humorous, balanced, but forceful fashion. The short films are played-back on mobile devices, now considered the fourth medium of entertainment following Cinema, TV and the computer. At this year's highlight of the mobile industry calendar, the 2009 MobileWorld Congress, Mobitel scooped the prize for the best operator in the MOFILM 2009 awards, and the CEO of Mobitel especially thanked the contribution of the ENTC Department students for the enthusiasm shown towards the competition. This is done in collaboration with the Architecture Faculty for theme assistance and CIT for technical assistance.

National Best Quality Software Award (NBQSA)

The National Best Quality Software Award (NBQSA) competition is an annual event organized by the British Computer Society Sri Lanka (BCSSL). The competition is open for sixteen categories of software ranging from Applications and Infrastructure Tools software to Media and Entertainment Applications Software In this globally competitive era the competition serves to showcase and benchmark Sri Lankan ICT products. The competition has been conducted in Sri Lanka by the Sri Lankan section of the British Computer Society for the past seven years. ***Web: www.nbqsasrilanka.org***

MIT-UoM Mobile Technologies Incubation Programme

This is a collaborative programme with the Massachusetts Institute of Technology(MIT) which was offered for the first time in June/July 2011. The objectives of this programme are:

- To infuse the spirit of entrepreneurship among students, specifically through innovations focused on mobile technologies.
- To provide necessary training on advanced mobile technologies for innovative services.
- To provide the framework to commercially deploy innovative mobile services.

This will be an intensive 8-week course conducted by instructors from MIT along with the assistance of UoM staff and industry leaders and entrepreneurs. The course will be available to a selected group of students with a good understanding of modern programming concepts and the spirit to innovate. The course will consist of brainstorming sessions for idea generation and fine-tuning, assistance with technical matters, business plan development, and establishing the necessary networks and contacts for the participants to launch their innovation as a commercial service. Competitions where financial and other valuable prizes will be offered to the winners is another componenet of this course.

AppZone Competition

App Zone Mobile application competition started on the 28th of September 2010 as a partnered project of Etisalat and hSenid. The AppZone competition is rewarding opportunity for the non professional Sri Lankan application developers to create, test and sell their own unique mobile applications. ***Web: www.appzone.lk***

Industry Collaboration

Dialog - University of Moratuwa Mobile Communications Research Laboratory

The Dialog - UoM Mobile Communications Research Laboratory specializes in applied research in mobile telecommunication technologies & internet applications. The Laboratory is funded by Dialog Axiata PLC and harnesses the leading edge technical capabilities inherent to the company, its parent Axiata Group Berhad and the University of Moratuwa. This is the first fully industry-sponsored research lab to be established in a University in Sri Lanka.

The lab has won many awards for its work. Among them are a National Best Quality Software Award and several National Science and Technology Awards. The lab has become finalists and received commendations in the GSM Asia Mobile Innovation Awards and the prestigious GSM Global Mobile Awards.

Our smart energy meter (SMC), an IoT-device with a novel pre-paid metering facility is now deployed by the partnering company LECO (Lanka Electric Company) at over 3000 locations of their customer network, and deployment is set to further expand in the near future. iMoni, the industrial monitoring system is in use at over 200 mobile network base station sites, and also at a number of other industrial facilities. Export opportunities are being explored. The eZ-Cash ATM is currently being rolled out at 200 locations in the Northern Province, with funding from the Australian Government. It has been well received by users. These products add value to telecom networks, improve living conditions of people and contribute towards advancing the industrial sector. Experiences gained through the partnership has also helped introduce state of the art content into the Department's curriculum.

Director: Prof. (Mrs.) S. A. D. Dias
Ext. No.: 3320
e-mail: dileeka@ent.mrt.ac.lk

Zone24x7-University of Moratuwa Electronic Systems Research Laboratory

The Zone24x7-University of Moratuwa Electronic Systems Research Laboratory is one of the two industry-sponsored research laboratories in the Department. Guided by the vision, “Global Research Locally”, the laboratory engages in carrying out cutting-edge world-class research.

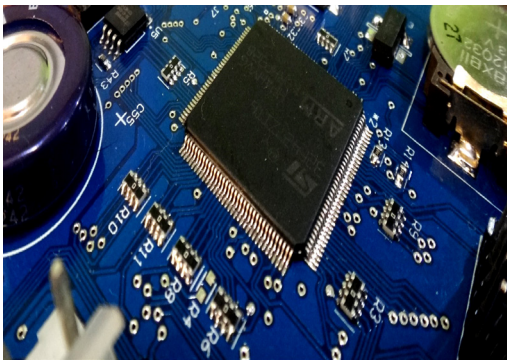
The research carried out in the laboratory span the areas of electronic systems, embedded systems, biomedical instrumentation, and computer vision. In the area of electronic and embedded systems, researchers in the laboratory are working on implementing recent computer vision algorithms on field programmable gate array devices. The non-invasive glucose meter project aims at estimating the blood glucose level without requiring pricking and obtaining a blood sample. The lab has developed algorithms for vision-based automatic room recognition with applications in the consumer robots and surveillance.

The laboratory employs top graduates as researchers who demonstrate a high research potential. The researchers in the laboratory benefit from state-of-the-art equipment, high-quality work and research environment while receiving research advice from the Department’s faculty and Zone24x7 parent company’s expertise. Some research students choose to follow an M.Sc. program at the Department as well. Some of them have secured admission to the prestigious graduate schools such as Johns Hopkins University.

Zone24x7 Inc., the sponsor of the laboratory, is a leading provider of global technology innovation services, headquartered in San Jose, California. The company offers information technology products and services specialized in business process and technology rationalization. Zone24x7’s blue chip clients includes fortune 1000 customers, leading hardware manufacturers and leading customers from retail, healthcare, and government sectors. Founded in 2003, Zone24x7 has technology development and research centers in many locations in USA, Malaysia and Sri Lanka. By collaborating with this vibrant industry partner, Zone24x7-University of Moratuwa Electronic Systems Research Laboratory strives to highlight the presence of Sri Lanka on the map, by carrying out world-class research at the Department of Electronic and Telecommunication Engineering.

Director: Eng. A.T.L.K. Samarasinghe
Ext. No.: 3326
e-mail: kithsiri@ent.mrt.ac.lk

PREMIUM-Internatioanl- University of Moratuwa Research and Development Laboratory for Biomedical Technologies



PREMIUM International - University of Moratuwa Research and Development Laboratory for Biomedical Technologies is the latest addition to the industry sponsored laboratories at the department premises. The Department of Electronic & Telecommunication Engineering has identified Biomedical Engineering as a key focus area and collaborated with the medical professionals in the development of novel medical product prototypes over the last few years. A major obstacle the department faced throughout has been the inability to commercialize the novel products developed despite their huge potential.

The lab focuses on medical product development for commercialization, addressing a long felt need of traversing the full path of product development and will be a place for creative medical professionals to take their innovative ideas from concepts to marketable products. Taking an idea to a useable product in the medical field is a long process that requires significant amount of testing in the actual environment and various types of approval. The laboratory will strive to comply with standards related to medical devices in developing products that can win the confidence of the medical community.

Sri Lanka, at present, does not manufacture any electronic based product for the local consumer market. The laboratory will provide a much needed boost to the local electronics manufacturing industry as it intends to go for a full scale manufacture of the developed prototypes with its industry partner Premium International.

The laboratory will also focus on applied research related to EEG, Tele-Medicine, Image guided therapy with the objective of developing futuristic products that will have a global appeal. In this process it will encourage all the research engineers to acquire postgraduate degrees based on the work done at the laboratory.

PREMIUM International - University of Moratuwa Research and Development Laboratory for Biomedical Technologies employs a few motivated and talented research engineers and accommodates interns for research and development activities every year. The department is expecting to promote the development of an industry in medical product manufacturing in Sri Lanka through activities of this laboratory.

Director: Dr. N.W.N. Daynanda
Ext. No.: 3349
e-mail: nuwan@ent.mrt.ac.lk

Other Useful Information

Getting Help and Advice

The academic staff of the Department of Electronic & Telecommunication Engineering is always ready to provide necessary help and advice in academic work, project work and experimental work. They are also ready to provide the necessary help and guidance in other student problems. The support staff of the Department are also helpful to students in completing their academic related work.

Product Innovation Team

The product innovation team is mainly supposed to cater the industry needs for new products as well as promote the existing innovations from the Department to the industry; also increase the research skills of the students. The team works both for new designs and enhancing the previous innovations up to the product level and keeps connections with the industry for marketing them. The team is supposed to earn the income for the research expenses through the products and consists of the lecturers, instructors, post graduates and the undergraduates.

Having many completed and on-going products, the team is supposed to change the view of the industry towards the university from an academic entity to a more advanced and useful place. Also it is expected to make profits to the Department by introducing successful projects to the industry.

ENTC Alumni Association

The alumni association of the Department of Electronics and Telecommunications Engineering was established to provide a range of benefits to its members. Its main objective is to create a strong relationship between the Department and the graduates in the industry such that both the parties will be benefited. It is mainly supposed to offer helping hand to increase the facilities of the Department, increase the link between the Department and the industry and to help the past graduates to gain knowledge through the Department.

General Information

There are some services provided by the Department for the convenience of its students. One of them is the photo copy service, which is run by the E-Club which is placed on the lower ground floor of the Department building. You can take photo copies as well as computer printouts at a very low rate from there. Another facility provided by the Department is the lockers for students. Using that, students can keep what ever they don't need to take home, safely.

IESL membership

"The Institute of Engineers, Sri Lanka (IESL) is the Primer professional body for Engineers in Sri Lanka. Its membership which has grown over the years presently stands at around 10,000 covering almost all disciplines of engineering. There are many attractions and benefits to those who join the IESL which is committed towards uplifting the status and the interests of the engineering profession in the country." The students can get the Student's membership by providing proof of following an approved Engineering course and furnishing original and copy of the birth certificate. The application form can be found at the following link:
www.iesl.lk/docs/membership

To apply for the memebership the students need to get the signatures from two corporate members of the IESL.

Corporate members of IESl in the department of Electronic and Telecommunication Engineering:

Prof. K.K.Y.W.Perera
Prof. J.A.K.S.Jayasinghe
Prof. S.A.D.Dias
Eng. A.T.L.K.Samarasinghe
Prof. S.R.Munasinghe

IET Membership

" The Institution of Engineering and Technology (IET) is one of the world's leading professional societies for the engineering and technology community, with more than 150,000 members in 127 countries and offices in Europe. North America and Asia-Pacific. The IET provides a global knowledge network to facilitate the exchange of ideas and promote the positive role of science, engineering and technology in the world." The Students can apply for the membership under the catagory 'Student or Apprentice'. The application process is mainly on-line based and the application forms are available in the following link: ***www.theiet.org***

IEEE Membership

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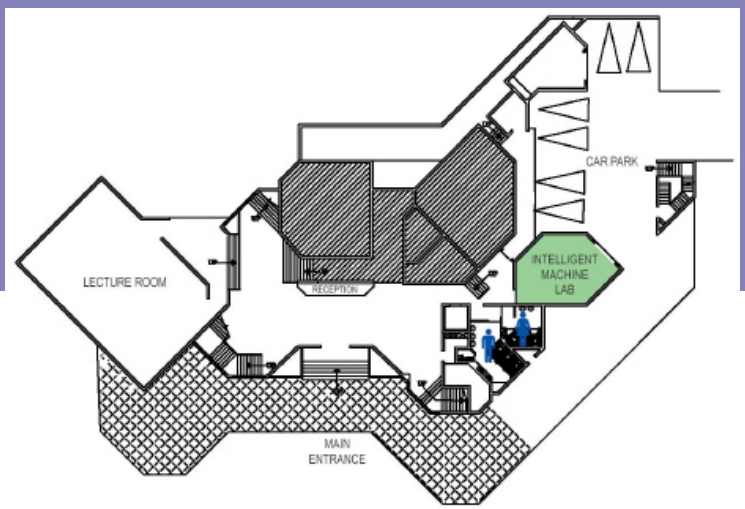
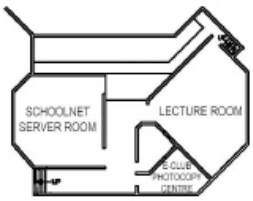
Frequently Asked Questions

Question	Contact Person	Where?
How do I register for the academic year?	SAR/Examinations (Ext. 1401)	Examinations Branch
How do I register for subjects?	Director/ Undergraduate Studies (Ext. 3051)	Undergraduate Office Sumanadasa Building
How do I find hostel accommodation?	Male/Female Sub-Wardens (Ext. 1850)	Hostel Office
How do I find addresses of private boarding places?	AR/ Welfare (Ext. 1831)	Welfare Office
Whom should I contact for bursary/ Mahapola scholarship	AR/ Welfare (Ext. 1831)	Welfare Office
How do I obtain bus/ train season tickets?	AR/ Welfare (Ext. 1831)	Welfare Office
What should I do if I fall ill?	University Medical Officer (Ext. 1810)	Medical Center
What should I do if I miss practical or continuous assessments? What should I do if I miss an examination?	Lecturer in Charge of Subject SAR/Examinations (Within 48 hours)* (Ext. 1401)	Examinations Branch
Whom should I contact for counseling matters?	Chief Student Counselor or Counselors	Counseling Office
Whom should I contact for security related issues?	Chief Security Officer (Ext. 1901)	Security Office
Whom should I contact for highly personal matters?	Professional Counselor (Ext. 1816)	L- Block

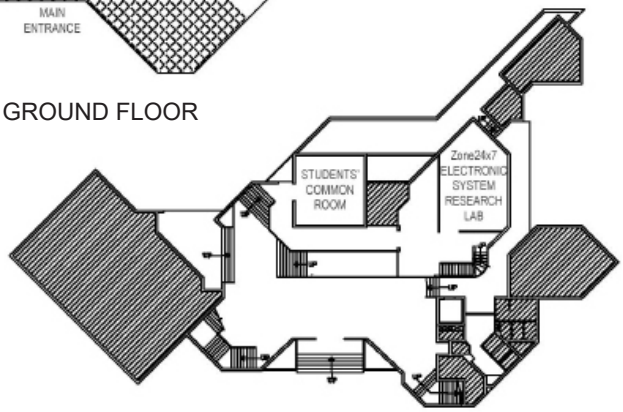
Floor Plan



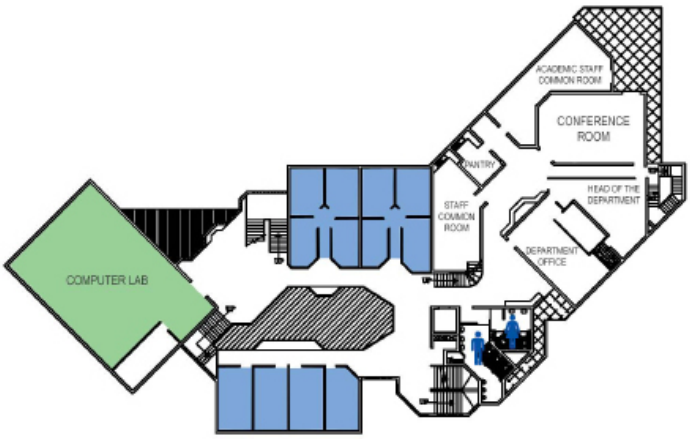
GROUND FLOOR



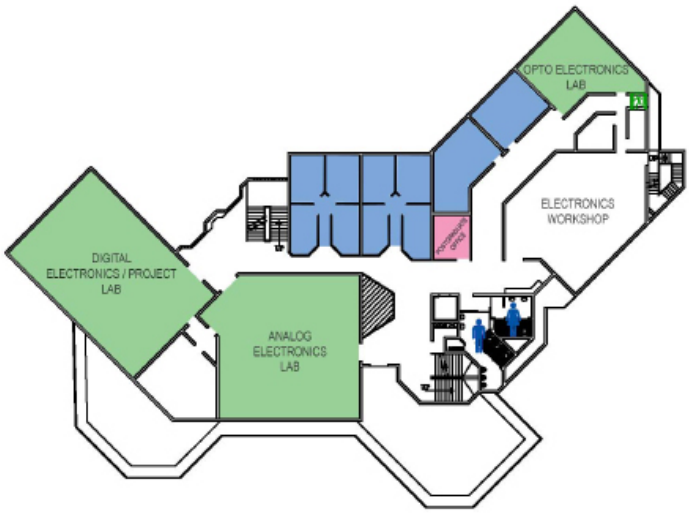
LOWER GROUND FLOOR



MEZZANINE ABOVE GROUND FLOOR



1ST FLOOR



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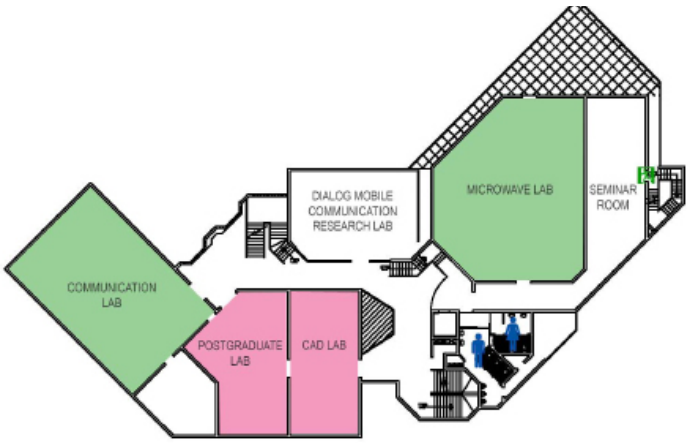

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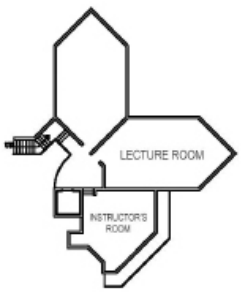

MEZZANINE ABOVE 3RD FLOOR