YESHWANTRAO CHAVAN COLLEGE OF ENGINEERING
(An Autonomous Institution affiliated to R T M Nagpur University Nagpur)
Accredited by NAAC (1st Cycle) with 'A' Grade (Score 3.25 on 4 Point Scale)
Wanadongri, Hingna Road, Nagpur-441110

Department of Electronics & Communications Engineering (Minor in MIAI)

B.E. Minor in Medical Imaging and Informatics SoE & Syllabus 2021-22

B.E Minor in Medical Imaging and Informatics

Information Brochure of Minor Program

1. Title of Program: **Medical Imaging and Informatics**
2. Type of Program : **Minor**
3. Department offering the program: **Electronics and Telecommunication Engineering**
4. Collaboration: **DATTA MEGHE MEDICAL COLLEGE**

   Hingna Road, Wanadongri,

   Nagpur, Maharashtra 440016

5. Department/s eligible to opt for the program:
6. The students from **EL, EE, ETC, CT, IT, CSE** are eligible to opt for this program. *Department of Civil Engineering students and Department of Mechanical Engineering students are not permitted to opt for the program.*
7. General information about courses in program:
   - The fusion of medical sciences and engineering would develop the skill based professional which is the need of current situation around the world. In line with the current social need, this course aims to provide an interdisciplinary teaching and research platform to the students.
   - The minor course in medical Imaging and informatics would give an insight of recent technology use for the clinical medical imaging application design, development, and assessment. Students can use the gained skills to develop newer technological innovations in biomedical field and regularize them for high-throughput clinical translation and usage.
   - The courses in the program include study of Human anatomy, medical physiology, medical imaging techniques along with biomedical image and physiological signal analysis, Python for medical data science, and machine learning for healthcare applications which provides the in-depth development of an engineering students in the interdisciplinary field of biomedical engineering.
   - Medical imaging techniques along with biomedical image and signal analysis helps students in biomedical application development.
   - Healthcare sector is getting transformed by the ability to record massive amounts of information about individual patients, the enormous volume of data being collected is impossible for human to analyze. Machine learning provides a way to automatically find patterns and reason about data.

- Students who are looking forward to pursue higher studies in biomedical Engineering in India or abroad or seek jobs in the field of software design for medical data analysis, medical imaging, medical visualization can enroll for this course.

8. Advance knowledge or research orientation of Program: (100 words)

- This course includes specialized courses with fusion of engineering and health care applications which are not covered in general engineering UG programs.
- Due to establishment of companies R&D centers in India like Philips, GE, Siemens R&D centers, great opportunity to the students to work as R&D engineer for medical image analysis and informatics.
- Students can have career in Healthcare sector, Research Centers, Biomedical Software development firms and Biomedical Engineering Firms

9. Employability potential of program:

Due to the great demand and scope of interdisciplinary skill based advance biomedical analysis tools with less human intervention, this minor course would be beneficial for carrying out live projects to solve issues faced by medical professionals, the employability/ entrepreneurship capability of students will be substantially increased due to this program.

- The knowledge of physiological signal and biomedical image analysis, data science, analysis of clinical data using machine learning will be very much beneficial for the students as most of the medical issues could be solved.
- Students who wish to pursue higher studies in the biomedical engineering filled will be immensely benefitted by this Minor programme.

10. Departmental Steering committee: For proper publicity / conduct of program

SN	Name of the Faculty Member	Post	Designation	e-mail ID	Contact Number
1	Dr. M. S. Narlawar	Asst. Prof.	HoD	hod_et@ycce.edu	9763822298
2	Dr. M. M. Mushrif	Prof.	Chairman	milindmushrif@gmail.com	9158888736
3	Dr. Y. U. Chitriv	Asst. Prof.	Member Secretary	yogeetakdubey@gmail.com	9922298656
4	Dr. A. D. Belsare	Asst. Prof.	Member	adbelsare@ycce.edu	8956312259
5	Dr. N. D. Rehpade	Asst. Prof.	Member	nitangp@gmail.com	8983084871

11. Program Coordinator:

SN	**Name of the Faculty Member**	**Post**	**Designation**	**e-mail ID**	**Contact Number**
1	Dr. M. M. Mushrif	Prof.	Chairman	milindmushrif@gmail.com	9158888736

Scheme of Examinations

B.E. Minor in Medical Imaging and Informatics

SN	Sem	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
					L	T	P	Hrs		MSEs*	TA**	ESE	
B.E. Minor in Medical Imaging and Informatics													
1	5	ETM131	Human Anatomy and Medical Physiology	T	3	0	0	3	3	30	30	40	2
2	5	ETM132	Physiological Signal Processing	T	3	0	0	3	3	30	30	40	2
3	5	ETM133	Python for Data Science	P	0	0	2	2	2		60	40	
4	6	ETM141	Biomedical Image Analysis	T	3	0	0	3	3	30	30	40	2
5	6	ETM142	Machine Learning for Health Care	T	3	0	0	3	3	30	30	40	2
6	6	ETM143	Image Analysis and Machine Learning Lab	P	0	0	2	2	1				
7	7	ETM151	Medical Imaging	T	3	0	0	3	3	30	30	40	2
8	7	ETM152	Mini Project	P	0	0	2	2	2		100		
			TOTAL		**15**	**0**	**6**	**21**	**20**				

MSEs* = Three MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment

TA ** = for Theory : 20 marks on lecture quizzes, 8 marks on assignments, 2 marks on class performance
TA** = for Practical : MSPA will be 15 marks each

V Semester

ETM131	**Human Anatomy & Medical Physiology**			L= 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Total	ESE Duration
*Best Two out of three MSE's would be considered	15	15	15	30	40	100	3 Hrs
Prerequisites							

Course Objective	**Course Outcome**
Students should be able to 1. Study the structure of human body, cells, heart , lungs and nervous system 2. Study the respiratory, Musculoskeletal System 3. Study of Body Defenses, Gastro Intestinal System (GIT) 4. Study the functioning of various systems with their application in medical imaging	Students will be able to 1. Comprehend the human anatomy in terms of their structure and functions 2. Understand cells, heart , lungs, nervous system 3. Comprehend the respiratory, Musculoskeletal System 4. Understand Body Defenses, Gastro Intestinal System (GIT)

UNIT I :Introduction to Cellular System:

Human body orientation, Structure and organelles, Cell membrane, transport across membrane**06Hrs**

UNIT II :

Hematological System:
Blood composition, Blood flow factorsregulating blood flow such as viscosity, radius, density, etc (Fahraeuslindqvist effect,Poiseuille's Law).

Renal and Respiratory System:
Structure of Kidney and nephron. Mechanism of Urine formation and acid base regulation,Dialysis. Components of respiratory system **06Hrs**

UNIT III :Cardiac System:

Structure of heart, Properties of Cardiac muscle, Cardiac muscle and pacemaker potential, cardiac cycle, ECG, Heart sound, volume and pressure changes **06Hrs**

UNIT IV :**Sensory System:**
Structure of a Neuron, Synaptic conduction, Conduction of action potential in neuron, Parts of brain cortical localization of functions EEG. Structure of eye, ear and auditory and visual pathways. The Lymphatic System & Body Defenses, developmental aspects**06Hrs**

UNIT V: Gastro Intestinal System (GIT)Structure of all organs of GIT (oesophagus Stomach, liver, Pancreas, intestine and colon) with their functions **06 Hrs**
UNIT VI: Musculoskeletal System, All bones and Joints **06Hrs**

Text Books:				
1	Essential of Human Anatomy and Physiology	12th Edition May 2017	Elaine N. Marie,	Pearson Education, New Delhi, 2007
2				
Reference Book:				
1	Review of Medical Physiology	Twenty-Sixth Edition, March 2019	W. F. Ganong	McGraw Hill, New Delhi,
2	Text Book of Physiology	8 Edition, 2019	Prof. A. K. Jain	Avichal Publishing Company, New Delhi, 2005

V Semester

ETM132	**Physiological Signal Processing**			L= 3	T = 0	P = 0	Credits = 3
Evaluation Scheme *Best Two out of three MSE's would be considered	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Total	ESE Duration
	15	15	15	30	40	100	3 Hrs
Prerequisites	Signals and Systems						

Course Objective

1. To Understand the fundamentals of biomedical signal acquisition and signal classification
2. To study the time and frequency domain analysis techniques of physiological signals.
3. To apply adaptive filtering techniques for cancelling noise and interference in the various bio-signals

Course Outcome

Students will be able to

1. Examine the basic signal processing for physiological signals
2. Analyze the bio-signals in time and frequency domain.
3. Apply an adaptive filtering algorithm for bio-signals
4. Comprehend the classification of bio signals using wavelets.
5. Demonstrate the feature reduction and classification methods for different bio-signals

UNIT I :

Physiological Signal Characteristics: Characteristics of dynamic biomedical signals – Noises-random – Structured and Physiological noises – Filters – IIR and FIR filters.
Spectrum Analysis: Spectrum – Power Spectral Density function –Cross Spectral Density and Coherence function – Cepstrum and Homomorphic filtering – Estimation of mean of finite time signals.

06Hrs

UNIT II :

Time Series Analysis: Time series analysis – Linear prediction models – Process order estimation – Lattice representation –Non-stationary process –Fixed segmentation – Adaptive segmentation – Application in EEG, PCG signals – Time varying analysis of Heart-rate variability –Model based ECG simulator.

06Hrs

UNIT III :

Frequency Domain Analysis: Spectral estimation – Blackman Tukey method – Periodogram – Model based estimation – Application in heart rate variability, PCG signals.

06Hrs

UNIT IV :

Adaptive Filtering: Filtering – LMS adaptive filter –Adaptive noise canceling in ECG – Improved adaptive filtering in FECG.

05Hrs

UNIT V:

Wavelet Detection and Bio-signal Classification: Wavelet detection in ECG – Structural features – Matched filtering – Adaptive wavelet detection –Detection of overlapping wavelets – Signal classification and recognition – Statistical signal classification –Linear discriminant function –Direct feature selection and ordering.

06Hrs

UNIT VI:

Time Frequency and Multivariate Analysis:
Back propagation neural network based classification – Application in Normal versus Ectopic ECG beats – Time frequency representation – Spectrogram – Wigner distribution – Time-Scale representation – Scalogram –Wavelet analysis – Data reduction techniques – ECG data compression – ECG characterization – Feature extraction – Wavelet packets – Multivariate component analysis –PCA – ICA.

07Hrs

Text Books:				
1	Biomedical Signal Processing	2nd edition	Rangaraj. M. Rangayyan	Wiley-IEEE Press 2015
Reference Book				
1	Biomedical Signal Processing: Principles and techniques		D. C. Reddy	Tata McGraw Hill, New Delhi, 2012
2	Bio-signal and Medical Image Processing	3rd edition	John L. Semmlow, Benjamin Griffel	CRC Press
3	Biomedical Signal Processing	1st edition	N.Vyas	University Science Press, New Delhi.

V Semester

ETM133	Python for Data Science			L= 0	T = 0	P = 2	Credits = 2
Evaluation Scheme	MSE-I	MSE-II	MSE III	CA	ESE	Total	ESE Duration
				60	40	100	3 Hrs
Prerequisites	Basic Programming						

Course Objective	Course Outcome
Students should be able to 1. Learn basics of python and data structure 2. Learn Python Programming Fundamentals 3. Learn pandas for data analysis in Python 4. Learn data visualization tools in python	Students will be able to 1. Apply the concepts of python basic and data structure for problem analysis 2. Apply python flow control and functions for programming 3. Use pandas package for data analysis in Python. 4. Create plots and visuals using matplotlib package

Unit I : Python Basics
Types**,** Expressions and Variables**,** String Operations

Unit II Python Data Structures
Lists and Tuples**,** Sets**,** Dictionaries

Unit III: Python Programming Fundamentals
Conditions and Branching, Loops, Functions, Objects and Classes

Unit IV: Working with Data in Python
Reading files with open, Writing files with open, Loading data with Pandas, Working with and Saving data with Pandas, Importing and Exporting Data in Python, Identify and Handle Missing Values, Data Formatting

Unit V: Introduction to Visualization Tools
Introduction to Matplotlib, Basic Plotting with Matplotlib, Line Plots, Area Plots, Histograms, Bar Charts

Unit VI: Specialized and advanced Visualization Tools
Pie Charts, Box Plots, Scatter Plots, Bubble Plots, Waffle Charts, Word Clouds, Seaborn and Regression Plots

Reference Courses:				
1	https://cognitiveclass.ai/courses/python-for-data-science		Joseph	Cognitive Class
2	https://courses.cognitiveclass.ai/courses/course-v1:CognitiveClass+DV0101EN+v1/course/			Cognitive Class

VI Semester

ETM141	Biomedical Image Analysis			L= 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Total	ESE Duration
*Best Two out of three MSE's would be considered	15	15	15	30	40	100	3 Hrs
Prerequisites							

Course Objective

Students should be able to

1. Discuss biomedical image fundamentals.
2. Learn artifacts removal image enhancement techniques.
3. Identify the segmentation techniques for feature extraction.
4. Study the shape and texture based methods.

Course Outcome

Students will be able to

1. Comprehend image acquisition and sampling.
2. Process the given images to enhance them in spatial and frequency domains.
3. Extract features from a given image by segmentation.
4. Analyze the shape and texture-based features.

UNIT I :

Introduction: Nature of biomedical images, objectives of biomedical image analysis, difficulties in image acquisition and analysis, characterization of image quality, digitization of images, dynamic range, contrast, histogram, blur and spread functions, resolution, signal-to-noise ratio.

06Hrs

UNIT II :

Removal of Artifacts: Characterization of artifacts and its removal, synchronized or multiframe averaging, spatial and frequency domain filters.

06Hrs

UNIT III :

Image Enhancement: Temporal subtraction, gray-scale transforms, histogram transformation, convolution mask operators, high frequency emphasis, homomorphic filtering for enhancement, adaptive contrast enhancement.

06Hrs

UNIT IV :

Image segmentation: Fundamentals, detection of isolated points and lines, edge detection, segmentation and region growing, optimal thresholding, region splitting and merging, morphological watersheds, detection of objects of known geometry. Applications based on image segmentation.

06Hrs

UNIT V:

Analysis of Shape: Representation of Shapes and Contours, Shape Factors Fourier Descriptors, Fractional Concavity, Analysis of Spicularity.

06Hrs

UNIT VI:

Analysis of Texture: Texture in Biomedical Images, Models for the Generation of Texture, Statistical Analysis of Texture, Laws Measures of Texture Energy, Fractal Analysis, Fourier domain Analysis of Texture.

06Hrs

Text Books:				
1	Biomedical Image Analysis	1st edition	Rangaraj. M. Rangayyan	CRC Press, 2005 http://bio.marstu.net/data/materials/books/biomedical.pdf
2	Medical image analysis	2nd Edition	Atam P Dhwan	Wiley-IEEE Press
Reference Book:				
1	Digital Image Processing	4th edition	R C Gonzalez & R E Woods	Pearson Education, 2018
2	Fundamentals of Digital Image processing	1st edition	A K Jain	PHI / Pearson Education 2011
3	Digital Image Processing and Analysis		Chanda and Majumder	PHI Learning Pvt. Ltd., 2004
4	Biomedical Imaging, Visualization, and Analysis		Taylor & Francis, Richard A. Robb	John Wiley & Sons, 1999.

VI Semester

ETM142	**Machine Learning for Health Care**			L= 3	T = 0	P = 0	Credits = 3
Evaluation Scheme *Best Two out of three MSE's would be considered	MSE-I	MSE-II	MSE III*	TA	ESE	Total	ESE Duration
	15	15	15	30	40	100	3 Hrs
Prerequisites	Basic probability, statistics and linear algebra						

Course Objective

Students should be able to

1) Understand the concepts of machine learning and regression models
2) Understand the concept of classification for model evaluation.
3) Learn Supervised and unsupervised learning algorithms.
4) Learn the concept of artificial neural network and deep networks

Course Outcome

Students will be able to

1) Apply and analyze the model using regression.
2) Apply and evaluate the performance of system for classification.
3) Apply Supervised and unsupervised learning for problem solving.
4) Apply neural network algorithms for classification.
5) Describe and evaluate deep neural network with computational complexity.

UNIT-1 Regression

Supervised and Unsupervised Learning, Regression, Model and Cost Function, Gradient Descent, Multivariate Linear Regression, Feature Scaling, Gradient Descent for multivariable, heart disease prediction

(06 Hours)

UNIT-2: Classification

Classification, Hypothesis Representation, Decision Boundary, Cost function and Gradient Descent, Multi-classification, Regularization, Model Evaluation, DNA Classification

(06 Hours)

UNIT-3: Supervised Learning

KNN, SVM, Decision tree, Naive Bayes Classifiers, Random Forest, breast cancer detection

(06 Hours)

UNIT 4: Unsupervised learning

K-means clustering, Hierarchical Clustering, DBSCAN Clustering, PCA, Anomaly Detection, Recommender System, Application on health data

(06 Hours)

Unit 5: Artificial Neural Network

Introduction to neural network, Activation Functions, Perceptron rule, Backpropagation, heart diseases prediction

(06 Hours)

Unit 6: Deep Learning

Introduction to deep learning, building blocks of CNN, Computational Complexity, CNN Architectures, medical image analysis

(06 Hours)

Text Books:			
1	Understanding Machine Learning. https://www.cse.huji.ac.il/~shais/ Understanding Machine Learning/ copy.html	Shai Shalev-Shwartz and Shai Ben-David.	Cambridge University Press. 2017
2	The Elements of Statistical Learning. https://web.stanford.edu/~hastie/ Elem Stat Learn/	Trevor Hastie, Robert Tibshirani and Jerome Friedman.	Second Edition 2009
3	Pattern Recognition and Machine Learning. https://www.microsoft.com/enus/research/people/cmbishop/downloads/	Christopher Bishop	Springer 2006
Reference Book:			
1	Foundations of Data Science.	Avrim Blum, John Hopcroft and Ravindran Kannan.	Januar y 2017
2	Deep Learning, Part II, http://www.deeplearningbook.or g/	Goodfellow, I., Bengio, Y., Courville, A.	MIT Press 2016
3	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy	MIT Press 2012
4	MACHINE LEARNING An Algorithmic Perspective	Stephen Marsland	Second Edition, Chapman & Hall/CRC

VI Semester

ETM143	**Image Analysis and Machine Learning Lab**			L= 0	T = 0	P = 2	Credits = 1
Evaluation Scheme	MSE-I	MSE-II	MSE III	CA	ESE	Total	ESE Duration
				60	40	100	3 Hrs
Prerequisites	Pyhon Programming						

Experiments Based on
Biomedical Image Enhancement
Biomedical Image Segmentation
Feature Extraction based on Shape analysis
Feature Extraction using Texture Features
Heart Disease Predication
Breast Cancer Detection
DNA Classification
Biomedical Image Classification

VII Semester

ETM151	**Biomedical Imaging**			L= 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	MSE-I*	MSE-II*	MSE-III*	TA	ESE	Total	ESE Duration
*Best Two out of three MSE's would be considered	15	15	15	30	40	100	3 Hrs
Prerequisites	Digital Image Processing for Medical Applications						

Course Objective

Students should be able to

1. Study the production of x-rays and its application in medical imaging
2. Study the different types of Radio diagnostic techniques
3. Study the special imaging techniques used for visualizing the cross sections of the body.

Course Outcome

Students will be able to

1. Comprehend the acquisition techniques involved in different X Ray medical imaging
2. Conceive the historical evolution of the imaging methods pertaining to computed tomography and to excel with different reconstruction techniques and programming techniques for noise removal.
3. Comprehend the principle of operation of modules employed in magnetic resonance imaging
4. Comprehend the Ultrasound imaging system and the principle of operation of modules employed in thermal imaging

UNIT I :

X – Rays: Nature of X-Rays - X-ray Absorption - Tissue Contrast. X-Ray Equipment – X-ray Tube, collimator, Bucky Grid, power supply. Digital Radiography - discrete digital detectors, storage phosphor and film Scanning. X-Ray Image intensifier tubes - Fluoroscopy – Digital Fluoroscopy. Angiography, Cine angiography. Digital Subtraction Angiography. Mammography

06Hrs

UNIT II :

Computed Tomography: Principles of Tomography - First to Fifth generation scanners – Image reconstruction Technique - Back projection and Iterative method. Spiral CT Scanning - Ultra fast CT Scanners- X-Ray Sources – Collimation – X-Ray Detectors – Viewing System

06Hrs

UNIT III :

Magnetic Resonance Imaging: Fundamentals of Magnetic Resonance- Interaction of nuclei with static Magnetic Field and Radio frequency wave – Rotation and Precession –induction of a magnetic resonance signal – bulk Magnetization – Relaxation Processes T1 and T2, **MRI System and its components:** MRI system- System Magnet, generation of Gradient magnetic Fields, Radio Frequency coils, Shim coils, Electronic components

06Hrs

UNIT IV:

Emission Imaging: Alpha, Beta, Gamma Emission, different types of Radiation Detectors, G.M. & Proportional Counters, Pulse Height Analysers, Isotopic, Scanners, Principle of PET and SPECT, PET/CT

06Hrs

UNIT V:

Ultrasound Imaging & Thermography: Wave propagation and interaction in Biological tissues, Acoustic radiation fields, continuous and pulsed excitation, Transducers and imaging systems, Scanning methods, Imaging Modes-A, B & M, Principles and theory of image generation, Thermography- Principle, detectors and applications.

06Hrs

UNIT VI:

Medical Image Computing & Visualization for Diagnosis and Therapy: Automated Image Computing, Computational Strategies for Automated Medical Image Computing, Data Classification/Regression, model fitting, 2D Visualization, 3D Rendering, VR, AR

06Hrs

Text Books:				
1	Fundamentals of Medical Imaging	2017, 3rd edition	Paul Suetens	Cambridge University Press, Cambridge, New York.
2				
Reference Book:				
1	Intermediate Physics for Medicine and Biology	2015, 1st edition,	Russell K. Hobbie, Bradley J. Roth	Springer International Publishing, Switzerland
2	Physics and Radiobiology of Nuclear Medicine	2013, 4th edition,	Gopal B. Saha	Springer, Verlag, New York

VII Semester

ETM152	**Mini Project**	L= 0	T = 0	P = 2	Credits = 2