MUTHAYAMMAL ENGINEERING COLLEGE
(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

MUST KNOW CONCEPTS

MKC

BME

2021-2022

Subject		19BMC17 & 19MDC17– Medical Signal Processing		
UNIT-1 ADAPTIVE FILTERS				
S.No	**Term**	**Notation (Symbol)**	**Concept/Definition/Meaning/Units/Equation/Expression**	**Units**
1.	Filter	-	In signal processing, a **filter** is a device or process that removes some unwanted components or features from a signal. Filters are widely used in electronics and communication, in radio, television, audio recording, radar, control systems. Music synthesis, image processing, and computer graphics.	-
2.	Types of Filter	-	• Non-linear or linear • Time-variant or time-invariant • Causal or non-causal • Analog or digital • Discrete-time or continuous-time • Passive or active type of continuous-time filter Infinite impulse response (IIR) or Finite impulse response (FIR) type of discrete-time	-
3.	Adaptive filter	-	• An adaptive filter is a **system with a linear filter that has a transfer function controlled by variable parameters and a means to adjust those**	-

			parameters according to an optimization algorithm.	
4.	Adaptive algorithm	-	❖ An adaptive algorithm is an algorithm that changes its	-
5.	Types of adaptive algorithm	-	• Recursive Least Square (RLS) Least Mean Square (LMS)	-
6.	Applications of adaptive algorithm	-	• Noise cancellation • Signal prediction • Adaptive feedback cancellation Echo cancellation	-
7.	Filter implementations	-	• Least mean squares filter • Recursive least squares filter Multi-delay block frequency domain adaptive filter	-
8.	Types of adaptive filters	-	The classical configurations of adaptive filtering are • **System identification** • **Prediction** • **Noise cancellation** **Inverse modelling**	-
9.	Principle of adaptive filter	-	❖ Adaptive filters are self-designing filters based on an algorithm which **allows the filter to learn the initial input statistics and to track them if they are time varying.** These filters estimate the deterministic signal and remove the noise un-correlated with the deterministic signal.	-
10.	Steepest method of descent	-	❖ A steepest descent algorithm would be an algorithm which follows the update rule, where at each iteration, the direction $\Delta x(k)$ is the steepest direction we can take. That is the algorithm continues its search in the direction which will minimize the value of function, given the current point.	-
11.	Limitation of steepest descent algorithm	-	❖ The main observation is that the steepest descent direction can be used with a different step size than the classical method that can sustainability improve the convergence. One disadvantage however **is the lack**	-

			of monotone convergence.	
12.	Adaptive noise canceller	-	❖ Adaptive noise cancelling (ANC) is a technique which is **very effective to remove additive noises from the contaminated signals.** It has been widely used in the fields or telecommunication, radar, and sonar signal processing.	-
13.	ECG noise cancellation using digital filters	-	❖ The method is based on cascading a zero-phase band-paper aims to remove not only the power line noise pass, an adaptive filter, and multi-band-pass filter. It and its harmonics, but also to remove other ECG provides an efficient method for removing noise from noises such as respiratory signal and ECG signal.	-
14.	ECG noise cancellation methods	-	• Arrhythmia classers • Arrhythmia detection and classification processes Filtering	-
15.	Interference cancellation method	-	❖ As an alternative, we propose interference cancellation, in which simultaneous signals are modelled and decoded together rather than treating all but one as random noise. This method greatly expands the conditions under which overlapping transmissions can be successfully received, even by a single receiver	-
16.	Removing power line interference	-	The power line interference (50Hz) from ECG signal can be removed by **adaptive filtering** while its harmonics and high frequency noise can be removed by implementing general notch rejection filters.	-
17.	Filter for eliminate powerline interference in ECG signal	-	❖ Powerline interference (50 or 60 Hz noise from mains supply) can be removed by using **a notch filter of 50 or 60 Hz** cut-off frequency. EMG noise is a high frequency noise of above 100 Hz and hence may be	-

			removed by a low-pass filter of an appropriate cut-off frequency.	
18.	Causes of powerline interference ECG signal	-	❖ Power line interference is easily recognizable since the interfering voltage in the ECG may have frequency 50Hz. ❖ The interference may be due to **stray effect of the alternating current fields due to loops in the patient's cables.** Other causes are loose contacts on the patient's cable as well as dirty electrodes.	-
19.	Successive interference cancellation work	-	Successive Interference Cancellation (SIC) is a technique used by a receiver in a wireless data transmission that **allows decoding of two or more packets that arrived simultaneously** (in a regular system, more packets arriving at the same time cause a collision).	-
20.	Filter used to remove the stationary powerline interference	-	Performance of two adaptive filters, such as, **normalized least mean square (NLMS) adaptive filter and recursive least square (RLS) adaptive filter** are compared with a traditional notch filter both in time and frequency domains to remove the power line interference from the ECG signal.	-
21.	Artifacts	-	❖ Electrocardiographic artifacts are defined as electrocardiographic alterations, not related to cardiac electrical activity. As a result of the ECG such as the baseline and waves can be distorted.	-
22.	Artifact in cardiology	-	Artifact is the name given to disturbances in rhythm monitoring caused by movement of the electrodes.	-
23.	Remove artifacts from ECG	-	❖ To remove undesirable artifacts, after creating ECG template, this signal was low	-
24.	Effect on motion artifact	-	❖ Motion artifacts are related to cardiac motion which are caused by cardiac pulmonary or body motion and can cause blurring or double images. Fast CTA scanners having more X-ray	-

			sources can reduce the motions artifacts since the patient has less time to move during the image acquisition.	
25	Types of motion artifact	-	• Fever (rigors) • Hypothermia (shivering) • Cardiopulmonary resuscitation (chest compressions) A non-compliant, mobile, talkative patient (the most common cause)	-
UNIT -2 DATA COMPRESSION TECHNIQUES				
26	Data compression	-	• Process of **encoding, restructuring** on otherwise **modifying data** in order to **reduce its size**.	-
27	Types of data compression	-	1. Lossy compression 2. Lossless compression	-
28	Lossy data compression	-	The size of the file is reduced by eliminating data in the file.	-
29	Lossless data compression	-	Does not lose any data in the compression process, whereas the file size is compressed.	-
30	Example of lossy data compression	-	• JPEG image • MPEG video • MP3 audio formats	-
31	Example of lossless data compression	-	• Executable programmes • Text documents • Source code (PNG, GIF, LZ77)	-
32	Importance of data compression	-	It can dramatically decrease the amount of storage a file takes up.	-
33	Effect of data compression	-	Compressing data in a table space significantly reduces the amount of disk space that is needed to store data. Helps improve buffer pool performance.	-
34	Data compression techniques	-	▪ Image compression ▪ Data compression ▪ Vector compression ▪ Wavelet compression ▪ Compression algorithm ▪ Compression ratio ▪ Lossless compression	-

			▪ Lossy compression	
35	Examples of compression	-	➢ Bridge ➢ Hydraulic process ➢ Spring ➢ Shoe sole ➢ Bicycle pump ➢ Sponge ➢ Plush toys ➢ Air suspension system	-
36	Data compression uses	-	1. Audio compression 2. Video compression	-
37	Lossless data compression techniques	-	a) Run length encoding (RLE) b) Lempel Ziv-Wetch (LZW) c) Huffman coding d) Arithmetic coding	-
38	Lossy data compression techniques	-	1. Transform coding 2. Discrete cosine transform (DCT) 3. Discrete wavelet transform (DWT)	-
39	Compression ratio	-	The ratio of the number of bits required to represent the data before compression to the number of bits required to represent the data after compression.	-
40	Huffman coding	-	This handless data compression of ASC11 characters. It constructs a full binary tree for various symbols after computing the probability of each symbol and place it in descending order.	-
41	ECG	-	An Electrocardiogram is a recording of electrical activity of heart over the time produced by an electrocardiograph.	-
42	Turning point algorithm	-	It was developed to reduce the sampling frequency of an ECG signal from 200 to 100 Hz.	-

43	ECG uses	-	It displays the voltage between pairs of three electrodes, and the muscle activity that they measure from different directions.	-
44	ECG data compression	-	The first class, significance point extraction, includes the **turning point algorithm, AZTEC and Fan algorithm.**	-
45	Uses of turning point algorithm	-	TP algorithm provides a way to reduce the effective sampling rate by half to 100sps by selectively saving important signal points.	-
46	Steps of turning point algorithm	-	1. Acquire the ECG signal 2. Take the first there samples and check for the condition **(x1-x0) * (x2-x1)<0 or (x1-x0) * (x2-x1)>0** 3. If the above condition -1 is correct then x1 is stored else x2 is stored. 4. Reconstructing the signal	-
47	Requirements of TP	-	i. Acquisition of ECG signals ii. MATLAB software iii. PC configuration with 2GB RAM, 320GB HARD DISK, 2GHZ Intel processor	-
48	Acquisition of ECG signal	-	The normal ECG signals are acquired using POLYPARA system.	-
49	MATLAB software	-	MATLAB version **R2009b** is used for implementing the programs.	-
50	Limitations of TP algorithm	-	TP algorithm is limited to compression ratio of 4:1. Include not equally spaced sampling and widening of waves.	-
UNIT -3 CARDIO LOGICAL SIGNAL PROCESSING				
51	Signal	-	A signal is a function that conveys information about a phenomenon. In electronics and telecommunications, it refers to any time varying voltage,	-

			current, or electromagnetic wave that carries information. A signal may also be defined as an observable change in a quality such as quantity.	
52	Signal processing	-	• Signal processing is an electrical engineering subfield that focuses on analysing, modifying, and synthesizing signals such as sound, images, and scientific measurements.	-
53	Cardio-logical signal	-	• Cardiac signals reflect the function of the autonomic nervous system (ANS) and have previously been associated with a range of self-regulatory behaviors such as emotion regulation and memory recall.	-
54	ECG	-	An electrocardiogram (ECG) is a simple test that can be used to check your heart's rhythm and electrical activity. Sensors attached to the skin are used to detect the electrical signals produced by your heart each time it beats.	-
55	ECG Parameters	-	The ECG parameters, such as fragmented QRS (fQRS), heart rate variability (HRV), T peak-T end (TpTe), heart rate turbulence (HRT) and T wave alternans (TWA) have predictive value for the arrhythmic events	-
56	ECG Parameters Estimation	-	Standard ECG paper allows an approximate estimation of the heart rate (HR) from an ECG recording. Each second of time is represented by 250 mm (5 large squares) along the horizontal axis. So if the number of large squares between each QRS complex is: 5 – the HR is 60 beats per minute.	-
57	ECG QRS detection	-	QRS detection is a preliminary step for detecting the heartbeat for the subsequent rhythm classification, so a high QRS detection rate method is the most significant part of the ECG analysis algorithm	-

58	QRS detection techniques	-	The Shannon energy envelope, wavelet transform, adaptive threshold, and adaptive filter	-
59	R-R Interval	-	Normal ECG values for waves and intervals are as follows: RR interval: 0.6-1.2 seconds. P wave: 80 milliseconds. PR interval: 120-200 milliseconds.	-
60	Estimation of R-R interval	-	It can be estimated by counting the number of QRS complexes in a 10 second period and multiplying that by 6 or by counting the pulse for 10 seconds and multiplying that by 6. If one RR interval measures 20 mm, then HR is 1500 / 20 = 75 BPM.	-
61	ST Segment	-	The ST segment is the flat, isoelectric section of the ECG between the end of the S wave (the J point) and the beginning of the T wave. The ST Segment represents the interval between ventricular depolarization and repolarization	-
62	Inclination	-	Inclination is defined as a tendency towards something, such as a behavior or a habit. An example of an inclination is the tendency a mother has to protect a child. … The act of inclining or the state of being inclined; a bend or tilt. The inclination of the child's head suggested sleep.	-
63	ST elevation	-	ST elevation refers to a finding on an electrocardiogram wherein the trace in the ST segment is abnormally high above the baseline.	-
64	Heart rhythm	-	In a typical heart rhythm, a tiny cluster of cells at the sinus node sends out an electrical signal. The signal then travels through the atria to the atrioventricular (AV) node and into the ventricles, causing them to contract and pump blood.	-
65	Rhythm analysis	-	The rhythm is best analyzed by looking at a rhythm strip. On a 12 lead ECG this is usually a 10 second recording from Lead II.	-
66	Arrythmia	-	Improper beating of the heart, whether irregular, too fast or too slow.	-

			Cardiac arrhythmia occurs when electrical impulses in the heart don't work properly.	
67	Arrythmia analysis	-	The most common test used to diagnose an arrhythmia is an electrocardiogram (EKG or ECG). Your doctor will run other tests as needed.	-
68	Arrythmia analysis monitoring	-	Arrhythmia analysis is available with most modern ECG monitoring equipment. Arrhythmias, particularly premature ventricular beats and ventricular tachycardia, can occur during surgery in children with or without heart disease	-
69	ECG Recording	-	Electrocardiography is the process of producing an electrocardiogram. It is a graph of voltage versus time of the electrical activity of the heart using electrodes placed on the skin.	-
70	ECG Waves	-	The waves on an ECG include the P wave, Q wave, R wave, S wave, T wave and U wave. Interval: The time between two specific ECG events. The intervals commonly measured on an ECG include the PR interval, QRS interval (also called QRS duration), QT interval and RR interval.	-
71	ECG Artifacts	-	Electrocardiograph (EKG) artifacts are defined as EKG abnormalities, which are a measurement of cardiac potentials on the body surface and are not related to electrical activity of the heart.	-
72	ECG Components	-	The main components of an EKG wave include the P wave, PR segment, QRS complex, ST segment, T wave, and TP segment.	-
73	ECG Process	-	An electrocardiogram (ECG or EKG) records the electrical signal from your heart to check for different heart conditions. Electrodes are placed on your chest to record your heart's electrical signals, which cause your heart to beat. The signals are shown as waves on an attached computer monitor or printer	-

74	Normal ECG Recording	-	The normal range of the ECG differed between men and women: heart rate 49 to 100 bpm vs. 55 to 108 bpm, P wave duration 81 to 130 ms vs. 84 to 130 ms, PR interval 119 to 210 ms vs. 120 to 202 ms, QRS duration 74 to 110 ms vs.	-
75	ECG Recorder	-	An ECG recording machine will usually show your heart rhythm and electrical activity as a graph displayed electronically or printed on paper. For an ambulatory ECG, the ECG machine will store the information about your heart electronically, which can be accessed by a doctor when the test is complete	-
UNIT-4 NEUROLOGICAL SIGNAL PROCESSING				
76	Neurological Signal Processing	-	Neural signal processing is a specialized area of signal processing aimed at extracting information or decoding intent from neural signals recorded from the central or peripheral nervous system.	-
77	Linear Prediction Theory	-	Linear prediction is a mathematical operation where future values of a discrete-time signal are estimated as a linear function of previous samples	-
78	The Autoregressive (Ar) Method	-	An autoregressive (AR) model predicts future behavior based on past behavior. It's used for forecasting when there is some correlation between values in a time series and the values that precede and succeed them.	-
79	Recursive Estimation	-	With above introduced concepts state, system model, measurement and measurement model, we can now define estimation in a more formal way. ... The practice of estimating a state recursively based only on the old state es- timate and the newly available measurement in each time is called recursive estimation.	-
80	Spectral Error Measure	-	One of these factors, spectral error, occurs when measuring a light source that has a different spectral output than the light used to calibrate the	-

			sensor.	
81	Adaptive Segmentation	-	Intensity-based classification of MR images has proven problematic, even when advanced techniques are used. ... This paper describes a new method called adaptive segmentation that uses knowledge of tissue intensity properties and intensity inhomogeneities to correct and segment MR images.	-
82	EEG	-	Intensity-based classification of MR images has proven problematic, even when advanced techniques are used. ... This paper describes a new method called adaptive segmentation that uses knowledge of tissue intensity properties and intensity inhomogeneities to correct and segment MR images.	-
83	EEG And It's Uses	-	An electroencephalogram (EEG) is a test used to evaluate the electrical activity in the brain.	-
84	EEG Test Used To Diagnose	-	The electroencephalogram (EEG) is a medical test used to measure the electrical activity of the brain. A number of electrodes are applied to your scalp. EEG can help diagnose a number of conditions including epilepsy, sleep disorders and brain tumours	-
85	EEG	-	An electroencephalogram (EEG) is a recording of brain activity. During the test, small sensors are attached to the scalp to pick up the electrical signals produced when brain cells send messages to each other.	-
86	Possible Causes of Abnormal EEG	-	Abnormal bleeding (hemorrhage) Drug or alcohol abuse Head injury Migraines(in some cases)	-
87	Abnormal EEG Treated	-	Epilepsy may be treated with antiepileptic medications (AEDs), diet therapy and surgery. Medications are the initial treatment choice for almost all patients with multiple seizures.	-
88	EEG Transient Detection	-	EEG Transients are isolated waveforms or complexes that are	-

			distinguishable from background activity.	
89	Four Basic EEG Patterns	-	Four simple periodic rhythms recorded in the EEG are alpha, beta, delta, and theta. These rhythms are identified by frequency (Hz or cycles/sec) and amplitude	-
90	Epileptic Seizures Firstaid	-	❖ Stay calm and remain with the person. ❖ If they have food or fluid in their mouth, roll them onto their side immediately. ❖ Keep them safe and protect them from injury. ❖ Place something soft under their head and loosen any tight clothing. Reassure the person until they recover.	-
91	Three Stages Of Epilepsy	-	Seizures take on many different forms and have a beginning (prodrome and aura), middle (ictal) and end (post-ictal) stage.	-
92	Epilepsy Affect Performance	-	This can be a problem for active people, and can contribute to low motivation to get out and exercise. Other side effects can include weight gain, blurred or double vision and poor balance and coordination which can also impact sports performance.	-
93	Epilepsy Affect Academic Performance	-	Children with epilepsy are at risk for having attention problems, learning disabilities, and other cognitive weaknesses, such as difficulty with memory or problem-solving skills	-
94	Epilepsy Considered Special Needs	-	The nation's special education law specifically mentions epilepsy in its definition of "Other Health Impairment," a category under which children may be found eligible for special education and related services.	-
95	Difference Between Seizure And Epilepsy	-	A seizure is a single occurrence, whereas epilepsy is a neurological condition characterized by two or more unprovoked seizures.	-
96	Outcome Of Epilepsy	-	Most individuals who develop epilepsy have a high likelihood of achieving remission.	-

97	Epilepsy Affect Memory	-	Any type of epileptic seizure could potentially affect your memory, either during or after a seizure. If you have lots of seizures, memory problems might happen more often.	-
98	Epilepsy A Serious Illness	-	Most seizures end on their own and cause minimal concerns. Yet during some seizures, people can injure themselves, develop other medical problems or life-threatening emergencies	-
99	Long Term Effects Of Epilepsy	-	Long lasting seizures, or status epilepticus, may also cause brain damage or death. People with epilepsy are eight times more likely than people without it to experience certain other chronic conditions, including dementia, migraine, heart disease, and depression.	-
100	Main Cause Of Epilepsy	-	In general, epilepsy and seizures result from abnormal circuit activity in the brain. Any event ranging from faulty wiring during brain development, brain inflammation, physical injury or infection can lead to seizure and epilepsy.	-
UNIT-5 SLEEP EEG				
101	Sleep EEG	-	A sleep EEG is a recording of the electrical activity of the brain while you are awake and then asleep.	-
102	Sleep EEG duration	-	A sleep-deprived EEG takes about 1-2 hours. This test is similar to a regular EEG, as described above, except without video.	-
103	Need of sleep EEG	-	A sleep EEG is carried out while you're asleep. It may be used if a routine EEG does not give enough information, or to test for sleep disorders.	-
104	Sleep EEG detection	-	ECG analysis is useful for the detection of sleep apnea and may help to differentiate causes of cardiac arrhythmias.	-
105	Sleep EEG child test	-	An electroencephalogram (EEG) is a test that measures the electrical activity in the brain .The electrodes are not painful to your child. An EEG	-

			usually takes about 60 to 90 minutes.	
106	Data acquisition	-	Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer.	-
107	Data acquisition example	-	A simple example is the process of measuring the temperature in a room as a digital value using a sensor such as a thermocouple.	-
108	Purpose of data acquisition	-	Data acquisition provides greater control over an organization's processes and faster response to failures that may occur.	-
109	Types of data acquisition	-	Data acquisition systems can be classified into the following two types. Analog Data Acquisition Systems. Digital Data Acquisition Systems.	-
110	Markov model	-	A Markov model is a stochastic model used to model pseudo-randomly changing systems.	-
111	Purpose of Marko model	-	Markov models can also be used to recognize patterns, make predictions and to learn the statistics of sequential data.	-
112	Markov chain	-	• A Markov chain is a mathematical process that transitions from one state to another within a finite number of possible states.	-
113	Use of Markov chain	-	Markov chains are a fairly common, and relatively simple, way to statistically model random processes.	-
114	MCMC	-	Markov Chain Monte Carlo	-
115	Power law example	-	Double the length of a side of a cube, we multiply the volume of the cube by a factor of eight. Each of these is an example of a power law relationship.	-
116	Hypnogram model parameter	-	• The automatic computation of the hypnogram and sleep Parameters, from the data … the sleep stage stacked autoencoder to constitute a 4-layer DNN	-

			model.	
117	Power law	-	A power law distribution has the form Y = k Xα, where: X and Y are variables of interest, α is the law's exponent, k is a constant.	-
118	Power law relationship	-	A power law is a relationship in which a relative change in one quantity gives rise to a proportional relative change in the other quantity, independent of the initial size of those quantities.	-
119	Power law noise	-	Power-law noise processes are models of precision oscillator noise that produce a particular slope on a spectral density plot.	-
120	Polysomnography	-	Polysomnography, also called a sleep study, is a comprehensive test used to diagnose sleep disorders.	-
121	Types of Sleep apnea	-	Obstructive sleep apnea, central sleep apnea, and complex sleep apnea.22-Sep-2021	-
122	Sleep apnea age	-	Sleep apnea affects many children and is most commonly found in children between 2 and 6 years of age, but can occur at any age.	-
123	Warning of sleep apnea	-	Awakening with a dry mouth , sore throat, Morning headache. Difficulty concentrating during the day.	-
124	Fail of sleep apnea test	-	Patients with OSA often breathe through their mouths, which may lead to inaccurate signals.	-
125	Disadvantage of polysomnography	-	Recording is performed in an unfamiliar environment. More expensive than limited channel monitoring.	-

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HOD