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# PRESIDENCY UNIVERSITY

## BENGALURU

**End - Term Examinations – December 2025**

**Date:** 13 – 12- 2025 **Time:** 01:00pm – 04:00pm

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| **School:** SOE | **Program:** B. Tech | |
| **Course Code:** ECE3063 | **Course Name:** Wearable Devices and its applications | |
| **Semester**: VII | **Max Marks**: 100 | **Weightage**: 50% |

| CO - Levels | CO1 | CO2 | CO3 | CO4 | CO5 | CO6 |
|---|---|---|---|---|---|---|
| Marks | 12 | 14 | 14 | 14 | 22 | 24 |

**Instructions:**

*(i) Read all questions carefully and answer accordingly.*

*(ii) Do not write anything on the question paper other than roll number.*

## Part A

**Answer ALL the Questions. Each question carries 2marks.** **10Q x 2M=20M**

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| **1.** | A Sports person uses a smartwatch to continuously check their heart rate without visiting a hospital. Which feature of wearable devices enables this? | **2 M** | **L2** | **CO1** |
| **2.** | A single-axis accelerometer is placed flat on a horizontal table surface such that its sensing axis is parallel to the tabletop. The accelerometer is stationary. What will be its output reading in g and why? | **2 M** | **L2** | **CO2** |
| **3.** | Magnetic sensors are used to measure position, proximity, displacement, and speed. What is the standard unit of measurement for magnetic field strength used in modern sensor specifications? | **2 M** | **L2** | **CO2** |
| **4.** | List two major clinical applications where in-shoe pressure measurement systems are commonly used. | **2 M** | **L2** | **CO3** |
| **5.** | Accelerometer converts mechanical motion into an electrical signal that can be interpreted as movement or orientation. Name two common applications of accelerometers in everyday consumer. | **2 M** | **L2** | **CO3** |

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| **6.** | Cameras in wearable devices are audio-visual recording systems that capture data from a first-person perspective . Define FOV (Field of View) in the context of wearable cameras. | **2 M** | **L2** | **CO4** |
| **7.** | List any three parameters that can be obtained or measured using a wearable camera. | **2 M** | **L2** | **CO4** |
| **8.** | Name two physiological parameters commonly measured using wearable devices. | **2 M** | **L2** | **CO5** |
| **9.** | AI-powered smart glasses is an example for assistive device. What is the main purpose of wearable sensors for visually impaired people? | **2 M** | **L2** | **CO6** |
| **10.** | What type of feedback is usually given by wearable devices for the visually impaired? | **2 M** | **L2** | **CO6** |

## Part B

**Answer the Questions.** **Total Marks 80M**

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| **11.** | Wearable computing systems are gaining popularity in areas such as education, entertainment, industrial safety, and space research. State at least four advantages of wearable computers and provide a single-sentence justification for each advantage. (10M)<br><br>(a) Differentiate between invasive and non-invasive wearable sensors with suitable examples. (4M)<br>(b) Discuss two advantages and two limitations of each type. (6M) | **20 M** | **L3** | **CO1 C05** |
| | **OR** | | | |
| **12.** | An international sports technology firm is planning to introduce a fitness-focused wearable device in India. The device will monitor hydration levels, muscle fatigue, and calorie expenditure for athletes and fitness enthusiasts.<br><br>(a) Identify and explain three key challenges the company might face in designing and marketing this wearable. (5 M)<br>(b) Discuss three opportunities that show the potential for success of this product in the Indian market. (5 M)<br><br>Smart intelligent clothing is an emerging area in wearable technology.<br><br>(a) Define smart intelligent clothing and explain its working principle. (4 M)<br>(b) List and describe any three applications of smart clothing in domains such as healthcare, sports, or military. (6 M) | **20 M** | **L3** | **CO1 C05** |

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| **13.** | Magnetic sensors detect magnetic field strength and direction, enabling orientation tracking, navigation, and motion sensing in | **20 M** | **L3** | **CO2 CO3** |

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| | wearable devices.Differentiate between AMR, GMR, and TMR Magnetic sensors. (10M)<br><br>**1.** A person is standing on a single force plate, and the total measured force from their foot is 750 N. They are wearing an instrumented insole with two sensors of different sizes placed under the heel.<br><br>Sensor A (Large): Area = 15 $cm^2$, Located at the Heel<br><br>Sensor B (Small): Area = 5 $cm^2$, Located at the Heel<br><br>The insole electronics record the following forces from these two sensors:<br><br>Force on Sensor A, F_A = 300 N and Force on Sensor B, F_B = 200 N<br><br>1. Calculate the Total Force recorded by the Heel Sensors.<br><br>2. Calculate the Pressure on each sensor (Sensor A and Sensor B).<br><br>3. The total ground reaction force from the foot is 750 N. What percentage of this total force is being carried by the heel?<br><br>4. Comment on the potential risk for an injury at the location of Sensor B based on your calculations. (10M) | | | |
| | **OR** | | | |
| **14.** | An in-shoe sensor array has 3 × 3 pressure sensors (9 sensors). Each sensor has an active area of 3.0 $cm^2$. The sensors are arranged in a square grid with 3.0 cm spacing between adjacent sensor centers. Coordinates (in cm) for the sensor centers are:<br><br>x = {0, 3, 6} (left → right)<br><br>y = {0, 3, 6} (rear → front)<br><br>Measured pressures (assume static snapshot) in kPa:<br><br>Row y = 0 (rear): P1 = 50 P2 = 60 P3 = 40<br>Row y = 3 (middle): P4 = 70 P5 = 120 P6 = 80<br>Row y = 6 (front): P7 = 55 P8 = 65 P9 = 45<br><br>Compute force under each sensor (in N) and total vertical force (N).<br><br>Compute the center of pressure (CoP) coordinates (x, y) in cm.<br><br>Convert total force to kgf (1 kgf ≈ 9.81 N).<br><br>Identify peak pressure (kPa) and convert it to N/$cm^2$.<br><br>Give a short interpretation. | **20 M** | **L3** | **CO2 CO3** |

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| **15.** | You are tasked with designing the core electronic architecture for a next-generation Augmented Reality (AR) smart glasses intended for continuous, hands-free video recording and real-time object recognition. Identify the five most critical hardware components | **20 M** | **L3** | **CO4** |

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| | required to make this system function, and in a single sentence for each, explain its role in enabling the camera and its output. (10M)<br><br>A user is wearing smart glasses with a miniature camera. The camera has a focal length (f) of 4 mm and an image sensor with a width (Sw) of 3.2 mm. The user is looking at an object 1 meter (D) away. What is the approximate width of the actual field of view (FoVw) at that distance? (10M) | | | |
| | **OR** | | | |
| **16.** | A wearable digital stethoscope uses a microphone to record Tracheal Breathing Sounds (TBS). The recorded TBS signal power $P_s$=1.0x10$^{-7}$ Watts. The initial background noise power from the environment is $P_{N,initial}$ =5.0x10$^{-6}$ Watts. A digital Noise Reduction (DNR) algorithm is applied which reduces the background noise power by 90%. Calculate the following:<br><br>1. The intial Signal-to-Noise Ratio ($SNR_{initial}$)in decibels (dB).<br><br>2. The final Noise Power ($P_{N,final}$) after applying the DNR algorithm.<br><br>3. The final Signal-to-Noise Ratio ($SNR_{final}$)in decibels (dB).<br><br>4. The improvement in SNR in dB achieved by the DNR algorithm.<br><br>Illustrate the impact of noise reduction algorithms on the quality of a wearable stethoscope's sound recording. | **20 M** | **L3** | **CO4** |

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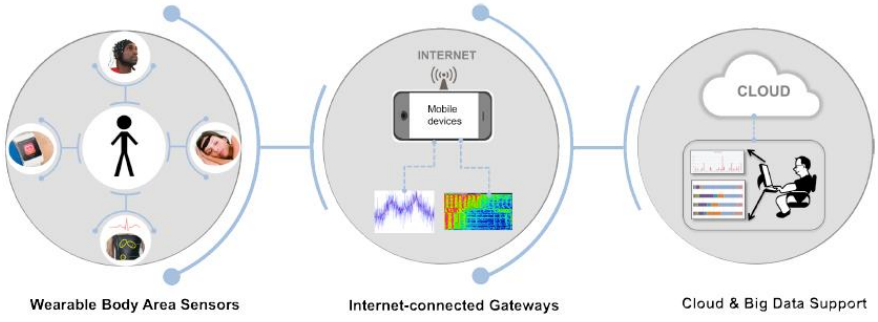
| **17.** | Compare ultrasonic-based and camera-based wearable assistive devices for the visually impaired. Describe the working principle of a camera-based wearable navigation system for visually impaired users. (10M)<br><br>A wearable obstacle detection system uses an ultrasonic sensor to locate an object. The sensor emits a pulse, and the reflected echo returns after t = 5.88ms (milliseconds). Given the speed of sound is approximately 340 m/s, calculate the distance (D) to the object in meters (m). (10M) | **20 M** | **L3** | **CO6** |
| | **OR** | | | |
| **18.** | A typical architecture of a WIoT is shown below.<br><br>  <br><br><br>Scenario: Consider the scenario near the Line of Control (LoC) which is a military control line between two nations — a line which does not constitute a legally recognized international boundary, but serves as the de facto border. Reinforced sandbagged and concrete posts and | **20 M** | **L3** | **CO6** |

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| | bunkers are among the first line of defence along the LoC. Armed soldiers man these positions with enough supplies for at least a week. The posts and bunkers allow soldiers to sleep, cook, and keep a watch on enemy positions round the clock. Some posts are located in remote locations and animals are sometimes used to help transport loads. Soldiers deployed on these posts communicate to their command centers through a data-radio set (looks like a smart-phone) which transmits on Very High Frequency (VHF) or Ultra High Frequency (UHF) and is configured to prevent enemy intercepts, using Army's own secure Mobile Cellular Communications Systems. The data-radio has other uses as well and can transmit audio, video, location coordinates etc.<br><br>You have been assigned to design a wearable device for soldiers having necessary capabilities for monitoring their vital parameters, detection of abnormalities, providing communication etc. Additionally, the system should be capable of monitoring soldier's activities when they enter enemy's areas for any emergency operations and inside bunkers. Under movement situations the system should have a provision to inform the soldiers locally and to those who are in bunkers, about their whereabouts and health status. The raw data which needs to be processed later should be delivered to an Army Command Center and/or Hospital, exploiting the WIoT architecture. It should be noted that the WIoT architecture should be designed considering its acceptance by a larger soldier community.<br><br>A complete WIoT architecture needs to be developed for the following requirements (without using any commercially available devices):<br><br>(i) Sensing Elements, their placement location and type of device (wrist-worn, body-hugging, ear-worn, head-mounted etc.)<br>(ii) Communication Elements (short range, medium range, long range)<br>(iii) Decision Making Algorithms: supervised / unsupervised classifier<br>(iv) Actuation and Command as well as Control center: based on requirement (15 M)<br><br>Tasks to do:<br><br>a) List all the required elements selected by you (from (i) to (iv)) for the given scenario by giving proper justification.<br>b) Represent the sequence of activities by using either a sequence chart or flow chart, which will be performed by each element (including the medical algorithms) in order to achieve the tasks visualized for the given scenario. (5 M)<br><br>Note: Suitable assumptions are allowed based on the scenario and / or need (however, specify them clearly). | | | |