Annamalai University

(Accredited with A+ Grade by NAAC)

Regulations, Curricula and Syllabi 2023-24

For

M.Sc. SPORTS BIOMECHANICS

PROGRAMME CODE: SSPO21

Approved by the Ministry of Youth Affairs & Sports
Government of India

MYAS – AU DEPARTMENT OF SPORTS SCIENCES

Centre of Excellence

Division of Sports Biomechanics

Faculty of Science

Annamalai University

Faculty of Science

MYAS-AU DEPARTMENT OF SPORTS SCIENCES

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M.Sc. SPORTS BIOMECHANICS

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These rules and regulations shall govern the Two year post graduate studies leading to the award of degree of **Master of Science in Sports Biomechanics** in the Faculty of Science. These academic Regulations shall be called **"Annamalai University, Faculty of Science Two year M.Sc. Sports Biomechanics Regulations 2023"**. They shall come into force with effect from the academic year 2023 – 2024. This syllabus is approved by **Ministry of Youth Affairs and Sports, Government of India,** and also revised in accordance to the template prescribed by **TANSCHE**.

1. Definitions and Nomenclature

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centers at the University.

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Sports Biomechanics is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 **Programme** encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc., MPT

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures / Laboratory / Seminar / Project work / viva-voce etc. Each course has a course title and is identified by a course code.

1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.

1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.

1.10 **Choice Based Credit System**: A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.12 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.13 **Programme Outcomes** (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably

manifest at the end of a programme.

1.14 **Programme Specific Outcomes** (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.15 **Course Objectives** are statements that define the expected goal of a course in course objectives in terms of demonstrable skills or knowledge that will be acquired by a student.

1.16 **Course Outcomes** (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.17 **Grade Point Average** (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.18 **Cumulative Grade Point Average** (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of total credits of all courses in all the semesters. Calculation of CGPA is given in section 11.4.

1.19 **Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2. Programme Offered and Eligibility Criteria:

The Department of Sports Sciences offers a Two Year M.Sc. in Sports Biomechanics programme. A pass in Bachelor's Degree in Sports Science / Physical Education and Sports / Sports Performance Analysis / Physics with Mathematics / Physiotherapy / Computer Science / Computer Application / Information Technology / Software Engineering or equivalent Mathematics / Statistics / Physics / Electronics / Applied Sciences / Engineering (Computer Science / E&I / IT) or equivalent thereto in 10+2+3 or 10+2+4 pattern from a recognized university with a minimum of 50% marks in aggregate. Proficiency in Sports is desirable.

3. Reservation Policy:

Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Two Year Master's Programme consist of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental), and Project.

5.2 Core courses

5.2.1 These are a set of compulsory courses essential for each programme.

5.2.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Project

5.3.1 Each student shall undertake a Project and submit a dissertation as per guidelines in the final semester.

5.3.2 The Head of the Department shall assign a Research Supervisor to the student.

5.3.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.3.4 Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the Department. The Research Supervisor will be from the

host institute.

5.4 **Elective courses**

5.4.1 Elective Course: Discipline Centric/ Generic is a course that a student can choose from a range of alternatives.

5.5 **Internship/Industrial Activity (Experiential Learning)**

5.5.1 Experiential learning in the form of internship/industrial activity provides opportunities to students to connect principles of the discipline with real-life situations.

5.5.2 In-plant training/field trips/internships/industrial visits fall under this category.

5.5.3 Experiential learning is categorized as non-core course.

5.6 **Industry/Entrepreneurship**

This course is to introduce students to the activity of setting up a business or businesses, taking on financial risks in the hope of profit.

5.7 **Skill Enhancement Course: SEC** is a course designed to provide value-based or skill-based knowledge. The main purpose of this course is to provide value-based or skills in the hands-on-mode to increase their employability.

5.8 Extension Activity: The basic objective of extension activity is to create social awareness and knowledge of social realities to have concern for the welfare of the community and engage in creative and constructive societal development.

5.8.1 It is mandatory for every student to participate in extension activity.

5.8.2 All the students should enroll under NSS/NCC/CYRC/RRC or any other service organization in the university.

5.8.3 Student should put a minimum attendance of 40 hours in a year duly certified by the Programme Co-Ordinator.

5.8.4 Extension activity shall be conducted outside the class hours.

5.8.5 Extension activity is categorized as non-core course.

5.9 Value Added Course (VAC)

5.9.1 Student may opt to take Value Added Course beyond the minimum credits required for the award of the degree. VACs are outside the normal credit paradigm.

5.10 Online Courses

5.10.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.10.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.11 **Credit Distribution:**

The credit distribution is organized as follows:

Components	Course	Credits
Part A	**Core (Theory)**	**45**
	Core (Practical)	**15**
	Project with Viva-Voce	**7**
Part B (i)	**Elective (Generic/Discipline Centric)**	**18**
Part B (ii)	**Internship/Industrial Visit**	**2**
Part B (iii)	**Skill Enhancement Course/Professional Competency Skill**	**6**
Part C	**Extension Activity**	**1**
	TOTAL CREDITS	**94**

Part A, Part B (i, ii, iii), and Part C will be considered for CGPA calculation and had to be complete during the duration of the programme as per norms, to be eligible for obtaining the PG degree.

5.12 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour duration per week over a semester

1 Tutorial period of one hour duration per week over a semester

1 Practical / Project period of two hours duration per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course teacher.

6.3 The record shall be submitted to the Head of the Department and Dean once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.

6.5 The Course teacher shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on

Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments and seminars. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Tests will be for one or two hours duration depending on the quantum of syllabus.

8.4.5 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.4.6 For the CIA Tests, the assessment will be done by the Course teacher

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first and third semester will be conducted in November and for the second and fourth semester in May.

8.6 Candidates who failed in any course will be permitted to reappear in failed course in the subsequent examinations.

8.7 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1 For each course, the Theory, Practical, Project, and Field visit shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will carry 40% and the ESE 60% of the marks.

9.1.4 Field visit shall be evaluated 100% internally by the committee based on the report submitted and presented.

9.2 Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the course instructor.

9.2.2 For the theory courses, the break-up of marks shall be as follows:

	Marks
Test-I & Test-II	15
Seminar	5
Assignment	5
Total	25

9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

	Marks
Test-I	10
Test-II	10
Viva-voce and Record	5
Total	25

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by Internal examiners.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		End Semester Examination (75 Marks)	
		Project / Dissertation Evaluation	Viva-voce
Review-I - 10	Review-II -15	50	25

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal. Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.2 The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 50% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed.

11.3 **The GPA** is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

11.4 **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$CGPA = \frac{\sum_{i=1}^{m}\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m}\sum_{i=1}^{n} C_i}$$

Where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

m is the number of semesters.

11.5 Evaluation:

11.5.1 **Performance of the student for each course will be rated as shown in the Table.**

Range of Marks	Grade Points	Letter Grade
90 and above	10	S
80-89	9	A
70-79	8	B
60-69	7	C
55-59	6	D
50-54	5	E
Less than 50	0	RA
Withdrawn from the examination	0	W

11.5.2 A ten point rating scale is used for evaluation of the performance of the student to provide overall grade for the Master's Programme.

11.6 **Classification of Results**. The successful candidates are classified as follows:

11.6.1 **For First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme in the first attempt with a CGPA of 8.25 and above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

CGPA	CLASSIFICATION OF FINAL RESULT
8.25 and above	First Class with Distinction
6.5 and above but below 8.25	First Class
5.0 and above but below 6.5	Second Class
0.0 and above but below 5.0	Re-appear

11.6.2 **For First Class:** Candidates who have passed all the courses with a CGPA of 6.5 and above.

11.6.3 **For Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11.6.4 Candidates who obtain highest marks in all examinations at the first appearance alone will be considered for University Rank.

11.6.5 **Formula for Conversion of CGPA into Percentage**

CGPA × 9.5 = Percentage

11.7 **Course-Wise Letter Grades**

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12 Provision for Withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.1 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.4 Application for withdrawal shall be considered only if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal will not be granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. **Academic misconduct:** Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on issues of academic integrity and ethics.

14. **Transitory Regulations:** Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent

subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.

Template for PG Programme in Sports Biomechanics

M.Sc. Sports Biomechanics (Two – Year)
Curriculum Design

Semester – I	C	H	Semester - II	C	H	Semester - III	C	H	Semester - IV	C	H
1.1. Core-I **Introduction to Sports Biomechanics**	5	6	2.1. Core-IV **Measurement Technique in Biomechanics**	5	5	3.1. Core-VII **Biomechanics of Human Gait**	5	5	4.1. Core-XI **Biomechanics of Footwear**	5	5
1.2. Core-II **Functional Anatomy**	5	6	2.2. Core-V **Neuromechanics of Human Movement**	5	5	3.2. Core-VIII **Application of Biomechanics to Physiological Systems**	5	5	4.2. Core-XII **Biomechanics of Musculoskeletal Injury**	5	5
1.3. Core-III - Practical I **Fundamental Assessments in Sports Biomechanics**	5	10	2.3. Core-VI - Practical II **Biomechanical Evaluation of Sports Movements**	5	10	3.3. Core-IX **Motor Learning and Control in Sports**	5	5	4.3. **Core Project with Viva-Voce**	7	14
1.4. Elective (Generic/Discipline Centric) – I (Group A) **a. Biomechanics of Biological Materials** **b. Orthopaedic Biomechanics**	3	4	2.4. Elective (Generic/Discipline Centric) – III (Group C) **a. Biomechanics of Human Joints** b. **Biomechanics of Asanas**	3	3	3.4. Core-X Practical III **Applied Physiology and Biomechanics in Human Performance**	5	10	4.4. Elective (Generic/Discipline Centric) – VI (Group F) **a. Applied Performance Analysis in Sports** **b. Methods in Neuromechanics**	3	3
1.5 Elective (Generic/Discipline Centric) – II (Group B) **a. Research Methodology and Statistics** **b. Advanced Kinematics and Dynamics**	3	4	2.5. Elective (Generic/Discipline Centric) – IV (Group D) **a. Essentials of Sports Performance Analysis** b. **Sports Performance and Excellence**	3	4	3.5. Internship	2		4.5. Skill Enhancement Course SEC III (Group I) **a. Biomechanical and Physiological Assessment of Running** **b. Introduction to 3D Modelling & Animation**	2	3
			2.6. Skill Enhancement Course SEC I (Group G) **a. Kinanthropometry and Sports Performance** **b. Statistics with R**	2	3	3.6. Elective (Generic/Discipline Centric) – V (Group E) **a. MATLAB** **b. Biomechanical Analysis of Human Movement**	3	3	4.6. Extension Activity	1	-
						3.7. Skill Enhancement Course SEC II (Group H) **a. Technical Training in Sports Biomechanics** **b. Programming with Python**	2	2			
						3.8. Non-Credit Course **a. Constitution of India**	-	-			
	21	**30**		**23**	**30**		**27**	**30**		**23**	**30**
									Total Credits	**94**	**120**

Credit Distribution for PG Programme in Sports Biomechanics
M.Sc. Sports Biomechanics (2 – Years)

First Year

Semester – I

Courses	Credit	Hours/Week
Core – 1: Introduction to Sports Biomechanics	5	6
Core – 2: Functional Anatomy	5	6
Core – 3: Practical – 1 Fundamental Assessment in Sports Biomechanics	5	10
Elective – 1 (Generic / Discipline Centric) (Choose Any **One** from **Group A**) a) Biomechanics of Biological Materials b) Orthopaedic Biomechanics	3	4
Elective – 2 (Generic / Discipline Centric) (Choose Any **One** from **Group B**) a) Research Methodology and Statistics b) Advanced Kinematics and Dynamics	3	4
Total	**21**	**30**

Semester – II

Courses	Credit	Hours/Week
Core – 4: Measurement Techniques in Biomechanics	5	5
Core – 5: Neuromechanics of Human Movement	5	5
Core – 6: Practical – 2 Biomechanical Evaluation of Sports Movements	5	10
Elective – 3 (Generic / Discipline Centric) (Choose Any **One** from **Group C**) a) Biomechanics of Human Joints b) Biomechanics of Asanas	3	3
Elective – 4 (Generic / Discipline Centric) (Choose Any **One** from **Group D**) a) Essentials of Sports Performance Analysis b) Sports Performance and Excellence	3	4
Skill Enhancement Course (SEC) – I (Choose Any **One** from **Group G**) a) Kinanthropometry and Sports Performance b) Statistics with R	2	3
Total	**23**	**30**

Second Year

Semester – III

Courses	Credit	Hours/Week
Core - 7: Biomechanics of Human Gait	5	5
Core - 8: Application of Biomechanics to Physiological Systems	5	5
Core - 9: Motor Learning and Control in Sports	5	5
Core - 10: Practical – 3 Applied Physiology and Biomechanics in Human Performance	5	10
Internship / Institutional training*	2	
Elective – 5 (Generic / Discipline Centric) (Choose Any **One** from **Group E**) a) MATLAB b) Biomechanical Analysis of Human Movement	3	3
Skill Enhancement Course (SEC) – I (Choose Any **One** from **Group H**) a) Technical Training in Sports Biomechanics b) Programming with Python	2	2
Constitution of India*	-	-
Total	**27**	**30**

*Non Credit Course

Semester – IV

Courses	Credit	Hours/Week
Core – 11: Biomechanics of Footwear	5	5
Core – 12: Biomechanics of Musculoskeletal Injury	5	5
Core Project (Dissertation with Viva Voce)	7	14
Elective – 6 (Generic / Discipline Centric) (Choose Any **One** from **Group F**) a) Applied Performance Analysis in Sports b) Methods in Neuromechanics	3	3
Skill Enhancement Course (SEC) – I (Choose Any **One** from **Group I**) a) Biomechanical and Physiological Assessment of Running b) Introduction to 3D Modelling & Animation	2	3
Extension Activity	1	-
Total	**23**	**30**

M.Sc. Sports Biomechanics (Two Year) Programme

Programme Code: SSPO21

Curricula and Scheme of Examination

(For students admitted from the academic year 2023-2024)

Course Code	Course Title	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
Semester I								
23MSBC101	Core – 1: Introduction to Sports Biomechanics	3	1	2	5	25	75	100
23MSBC102	Core – 2: Functional Anatomy	3	1	2	5	25	75	100
23MSBP103	Core – 3: Practical – 1 Fundamental Assessments in Sports Biomechanics			10	5	25	75	100
	Elective – 1 (Generic / Discipline Centric) (Choose Any **One** from **Group A**)							
23MSBE104	*a.* Biomechanics of Biological Materials	2		2	3	25	75	100
23MSBE105	b. Orthopaedic Biomechanics							
	Elective – 2 (Generic / Discipline Centric) (Choose Any **One** from **Group B**)							
23MSBE106	*a.* Research Methodology and Statistics	2		2	3	25	75	100
23MSBE107	b. Advanced Kinematics and Dynamics							
Total Credits and Marks in Semester - I		**30**			**21**	**125**	**375**	**500**

Course Code	Course Title	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
Semester II								
23MSBC201	Core – 4: Measurement Techniques in Biomechanics	4	1		5	25	75	100
23MSBC202	Core – 5: Neuromechanics of Human Movement	4	1		5	25	75	100
23MSBP203	Core – 6: Practical – 2 Biomechanical Evaluation of Sports Movements			10	5	25	75	100
	Elective – 3 (Generic / Discipline Centric) (Choose Any **One** from **Group C**)							
23MSBE204	a. Biomechanics of Human Joints	2	1		3	25	75	100
23MSBE205	b. Biomechanics of Asanas							
	Elective – 4 (Generic / Discipline Centric) (Choose Any **One** from **Group D**)							
23MSBE206	a. Essentials of Sports Performance Analysis	2		2	3	25	75	100
23MSBE207	b. Sports Performance and Excellence							
	Skill Enhancement Course (SEC) – 1 (Choose Any **One** from **Group G**)							
23MSBS208	a. Kinanthropometry and Sports Performance	1		2	2	25	75	100
23MSBS209	b. Statistics with R							
Total Credits and Marks in Semester - II		**30**			**23**	**150**	**450**	**600**

Course Code	Course Title	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
Semester III								
23MSBC301	Core - 7: Biomechanics of Human Gait	4	1		5	25	75	100
23MSBC302	Core - 8: Application of Biomechanics to Physiological Systems	4	1		5	25	75	100
23MSBC303	Core - 9: Motor Learning and Control in Sports	4	1		5	25	75	100
23MSBP304	Core - 10: Practical – 3 Applied Physiology and Biomechanics in Human Performance			10	5	25	75	100
23MSBI305	Internship / Institutional training*			-	2	25	75	100
	Elective – 5 (Generic / Discipline Centric) (Choose Any **One** from **Group E**)							
23MSBE306	MATLAB	3			3	25	75	100
23MSBE307	Biomechanical Analysis of Human Movement							
	Skill Enhancement Course (SEC) – 2 (Choose Any **One** from **Group H**)							
23MSBS308	a. Technical Training in Sports Biomechanics	2			2	25	75	100
23MSBS309	b. Programming with Python							
19PSCI406	Constitution of India[#]	-			-	25	75	100
	Total Credits and Marks in Semester - III	**30**			**27**	**175**	**525**	**700**

Course Code	Course Title	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
Semester IV								
23MSBC401	Core – 11: Biomechanics of Footwear	4	1		5	25	75	100
23MSBC402	Core – 12: Biomechanics of Musculoskeletal Injury	4	1		5	25	75	100
23MSBD403	Dissertation with Viva Voce			14	7	25	75	100
	Elective – 6 (Generic / Discipline Centric) (Choose Any **One** from **Group F**)							
23MSBE404	Applied Performance Analysis in Sports	2	1		3	25	75	100
23MSBE405	Methods in Neuromechanics							
	Skill Enhancement Course (SEC) – 2 (Choose Any **One** from **Group I**)							
23MSBS406	a. Biomechanical and Physiological Assessment of Running	1		2	2	25	75	100
23MSBS407	b. Introduction to 3D Modelling & Animation							
23MSBX408	Extension activity			-	1	25	75	100
	Total Credits and Marks in Semester - IV	**30**			**23**	**150**	**450**	**600**
	Total (Hours, Credits and Marks)	**120**			**94**	**600**	**1800**	**2400**
[#]Non Credit Course; *Internship during Second Semester Summer Vacation								
L- Lectures; T – Tutorial, P- Practical; C- Credits;								

Compound Wise Credit Distribution

Credits	Sem I	Sem II	Sem III	Sem IV	Total
Part A	**15**	**15**	**20**	**17**	**67**
Part B					
i) Elective (Generic/Discipline Centric)	**6**	**6**	**3**	**3**	**18**
ii) Internship/Industrial Visit		**2**	**2**	**2**	**6**
iii) Skill Enhancement Course/Professional Competency Skill			**2**		**2**
Part C i) Extension Activity				**1**	**1**
Total	**21**	**23**	**27**	**23**	**94**

Part A, Part B (i, ii, iii), and Part C will be considered for CGPA calculation and had to complete during the duration of the programme as per norms, to be eligible for obtaining the PG degree.

ELECTIVE COURSES

Courses are grouped (Group A to Group F) so as to include topics from Sports Biomechanics (SB), Applied Sports Biomechanics (ASB) and Sports Science Components (SSC) like Sports Authority of India, State Development Authority of Tamilnadu, Private Sports Science labs, etc., courses for flexibility of choice by the stake holders institutions. They have to choose a course from each group.

Semester I: Elective I and Elective II

Elective I to be chosen from **Group A** and **Elective II** to be chosen from **Group B**

Group A: (SB / ASB / SSC)

1. Biomechanics of Biological Materials
2. Orthopaedic Biomechanics

Group B: (SB / ASB / SSC)

1. Research Methodology and Statistics
2. Advanced Kinematics and Dynamics

Semester II: Elective III & Elective IV

Elective III to be chosen from **Group C** and **Elective IV** to be chosen from **Group D**

Group C: **(SB / ASB / SSC)**

1. Biomechanics of Human Joints
2. Biomechanics of Asanas

Group D: (SB / ASB / SSC)

1. Essentials of Sports Performance Analysis
2. Sports Performance and Excellence

Semester III: Elective V

Elective V to be chosen from Group E

Group E: (SB / ASB / SSC)

1. MATLAB
2. Biomechanical Analysis of Human Movement

Semester IV: Elective VI

Elective VI to be chosen from Group F

Group F: (SB / ASB / SSC)

1. Applied Performance Analysis in Sports
2. Methods in Neuromechanics

Skill Enhancement Courses

Skill Enhancement Courses are chosen to keep in pace with the latest developments in the academic / industrial front and provides flexibility of choice by the stakeholders /institutions. They have to choose a course from each group.

Group G to I (Skill Enhancement Courses) SEC: (Practical based paper)

Semester II

SEC I to be chosen from Group G

1. Kinanthropometry and Sports Performance
2. Statistics with R

Semester III

SEC II to be chosen from Group H

1. Technical Training in Sports Biomechanics
2. Programming with Python

Semester IV

SEC III to be chosen from Group I

1. Biomechanical and Physiological Assessment of Running
2. Introduction to 3D Modelling & Animation

Written Examination: Theory Paper (Bloom's Taxonomy based)

Question paper Model

Intended Learning Skill	Maximum – 75 Marks
	Passing Minimum – 50%
	Duration – Three Hours
	Part – A (10 × 2 = 20) Answer *ALL* Questions Each Questions carries 2 marks
Memory Recall / Example / Counter Example Knowledge about the Concepts / Understanding	Two Questions from each UNIT
	Question 1 to Question 10
	Part – B (5 × 5 = 25) Answer *ALL* Questions Each Questions carries 5 marks
Descriptions / Application (Problem)	Either or Type Both parts of each questions from the same UNIT
	Question 11(a) or 11(b) To Question 15(a) or 15(b)
	Part – C (3 × 10 = 30) Answer any *THREE* Questions Each Questions carries 10 marks
Analysis / Synthesis / Evaluation	There shall be FIVE questions covering all the five units and each with a question
	Question 16 to Question 20

Methods of Assessment

Recall (K1)	Simple Definitions, MCQ, Recall Steps, Concept Definitions.
Understand / Comprehend (K2)	MCQ, True/False, Short Answer, Concept Explanations, Short Summary or Overview.
Application (K3)	Suggest idea / Concept with examples, suggest formulae, Solve problems, Observe, Explain.
Analyse (K4)	Problem Solving questions, finish a procedure in many steps, Differentiate between various ideas, map knowledge.
Evaluate (K5)	Longer essay / Evaluation essay, Critique or justify with pros and cons.
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentation.

In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) or Lower to minimum, M-Medium (2) and Strong-S (3) to maximum.

The S, M, L is based on the course outcome. The mapping is based on the revised Bloom's Taxonomy Verb used to describe the course outcomes.

- Remember and Understand – Lower Level
- Apply and Analyse – Medium Level
- Evaluate and Create – Strong Level.

Each question should carry the course outcome and cognitive level for instance.

1. [CO1: K2] Question xxxx
2. [CO2: K1] Question xxxx

Introduction: PO & PSO

Programme Outcome, Programme Specific Outcome and Course Outcome

Students completing this programme will be able to present their core post-graduate discipline clearly and precisely, make abstract ideas precise by formulating them in the language of the specific discipline, describe related ideas from multiple perspectives and explain fundamental concepts. Completion of this programme will also enable the learners to join teaching profession, enhance their employability for government jobs, jobs in various other public and private enterprises.

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc. SPORTS BIOMECHANICS**
Programme Code	**SSPO21**
Duration	**2 years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
	PO2: Decision Making Skill Foster analytical and critical thinking abilities for data-based decision-making.
	PO3: Ethical Value Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
	PO4: Communication Skill Ability to develop communication, managerial and interpersonal skills.
	PO5: Individual and Team Leadership Skill Capability to lead themselves and the team to achieve organizational goals.
	PO6: Employability Skill Inculcate contemporary business practices to enhance employability skills in the competitive environment.
	PO7: Entrepreneurial Skill Equip with skills and competencies to become an entrepreneur.
	PO8: Contribution to Society Succeed in career endeavors and contribute significantly to society.
	PO 9 Multicultural competence Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
	PO 10: Moral and ethical awareness/reasoning Ability to embrace moral/ethical values in conducting one's life.

Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.
	PSO 2 - Entrepreneur To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
	PSO3 – Research and Development Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.
	PSO4 – Contribution to Business World To produce employable, ethical and innovative professionals to sustain in the dynamic business world.
	PSO 5 – Contribution to the Society To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Semester	23MSBC101: Introduction to Sports Biomechanics	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
I		3	1	2	5	25	75	100

Learning Objective (LO):

LO1	This course is to learn mechanical concepts and principles that govern human movement
LO2	To build skills in quantitative and qualitative analyses of sports and games
LO3	To link theory and practice of course concepts and application in sports

Unit 1 - Introduction of Fundamentals of Biomechanics

Biomechanics: Definition and Perspective, Problems studied by biomechanicsts, Importance of biomechanics, Goals of Sports Biomechanics – Performance Enhancement, Technique, Equipment, Training, Injury Prevention and Rehabilitation, Elementary Trigonometry - Definition of Trigonometry, Pythagoras Theorem, Trigonometric Ratios in right triangles, Problems related to skill, Units of measurements. Kinematic, Kinetic, Linear, Angular, Forms of Motion – Linear, Angular and General

Unit 2 – Linear and Angular Kinematics

Linear Kinematic Quantities: Distance, Displacement, Speed, velocity, Acceleration – Average and instantaneous quantities, Kinematics of Projectile motion – Horizontal & Vertical components, Influence of gravity, Influence of air resistance, Factors influencing Projectile trajectory – Projection angle, Projection speed, Relative projection height, optimum projection conditions, Analysing Projectile Motion – Equations of constant acceleration. Angular Kinematics - Angular Distance, Displacement, Speed, Velocity, motion vectors, average versus instantaneous angular quantities, Relationship between Linear and Angular Motion – Linear and Angular displacement, Linear and Angular velocity, Linear and Angular Acceleration.

Unit 3 – Linear Kinetics & Equilibrium

Newton’s laws – Law of Inertia, Law of Acceleration, Law of Reaction, Law of Gravitational. Mechanical Behaviour of Bodies in Contact – Friction, Momentum, Impulse, Impact. Work, Power, and Energy – Relationship, Conservation of Mechanical Energy, Principle of Work and Energy. Equilibrium – Torque, Resultant Joint Torque, Levers, Anatomical Levers Equation of Static Equilibrium, Equations of Dynamic Equilibrium, Centre of Gravity – Locating Centre of Gravity, Locating the human Body Centre of Gravity, Stability and Balance.

Unit 4 – Angular Kinetics

Resistance to Angular Acceleration – Moment of Inertia, Determining moment of Inertia, Human body Moment of Inertia, Angular Momentum – Conservation of Angular Momentum, Transfer of Angular Momentum, Change in Angular Momentum, Angular Analogues of Newton’s Laws of Motion – Newton’s First, Second, Third Laws, Centripetal Force, Centrifugal Force.

Unit 5 – Fluid Mechanics

The Nature of Fluids – Relative Motion, laminar versus Turbulent Flow, Fluid Properties, Buoyancy – Characteristics of the Buoyant Force, Flotation, Flotation of the Human Body, Drag – Skin Friction, Form Drag, Wave Drag, Lift Force - Foil Shape, Magnus Effect, Propulsion in Fluid Medium – Propulsive Drag theory, Propulsive Lift Theory, Vortex Generation, Stroke technique.

Text Books

1. Bunn, John W. (1972), *Scientific Principles of Coaching* (2nd Edition), Prentice Hall, Inc., USA.
2. Hall, Susan J. (2004), *Basic Biomechanics* (4th Edition), MC Graw-Hill Companies, USA.
3. Hay, James G. (1993), *The Biomechanics of Sports Techniques* (4th Edition), Prentice Hall, USA.
4. Kreighbaum, Ellen and Barthels, (1990), *Biomechanics – A qualitative Approach for studying Human movement* (3rd Edition), MC Millan Publishing Company, USA.
5. Mc. Ginnis, Peter M., (2005), *Biomechanics of Sport and Exercise* (2nd Edition), Human Kinetics Publishers, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Use mechanical principles to describe simple sport and exercise movements
CO2	Know the key relationships within kinematics and how they interact in sport and exercise movements
CO3	Know the different aspects of kinetics in relation to sport and exercise movements
CO4	Solve basic theoretical problems in mechanics using mathematical skills
CO5	Analyse basic biomechanical data using appropriate techniques

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	2	2	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3
	Weightage										15	15	15	15	15
	Weighted Percentage of Course Contribution to PSO's										3.0	3.0	3.0	3.0	3.0

Semester	23MSBC102: Functional Anatomy	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
I		3	1	2	5	25	75	100

Learning Objective (LO):

LO1	To study about muscles, joints and bones associated with shoulder, wrist, fingers, hip, ankle, foot, and vertebral column and their role on movements
LO2	To study about the contribution of upper and lower extremity musculature to sports skills
LO3	To study about the forces acting at joints to enhance sports performance

Unit 1 – Skeletal system

Anatomy, Kinesiology, Structural kinesiology, Reference positions, Reference lines, Anatomical directional terminologies, Alignment variation terminology, Planes of motion, Axes of rotation, Body region. Skeletal systems – Structure, function, Types of bones, Features of bones, Bone development and growth, Bone properties, Bone markings, Joints - Types of joints, Movements in joints.

Unit 2 – Skeletal muscle and nerves

Skeletal muscles, Muscle nomenclature, Shape of muscles and arrangement, Muscle tissue properties, Muscle terminology, types of muscle contraction (action), Role of muscles, Tying the roles of muscle together, Determination of muscle action, Neural control of voluntary movement, Proprioception and kinesthesis, Neuromuscular concepts – Motor units and the all or none principle, Muscle fiber type, Factor affecting muscle tension development, Muscle length- tension relationship, Muscle force-velocity relationship, Stretch shortening cycle, Reciprocal inhibition or innervation, Angle of pull, Uniarticular, biarticular, and multiarticular muscles, Active and passive insufficiency.

Types of mechanics found in the body – lever, Factors in use of anatomical levers, Wheel and axles, Pulleys, Laws of motion and physical activities, Friction, Balance, equilibrium, and stability, Force, Mechanical loading basis, Functional application.

Unit 3 – The Shoulder Girdle, Shoulder Joint, Elbow joint, Wrist and Hand joints

Bones, Joints, Movements, Muscles, Nerves

Unit 4 – The Hip Joint, Pelvic Girdle, Knee Joint, Ankle and Foot Joint

Bones, Joints, Movements, Muscles, Nerves

Unit 5 – The Trunk and Spinal Column and Muscular analysis of selected exercises and related concepts

Bones, Joints, Movements, Muscles, Nerves; Upper extremity activities concepts and analysis, Analysis of movement, The kinetic chain concepts – conditioning, Valsalva maneuver, Analysis of selected exercises – Shoulder pull, Arm curl, Triceps extension, Barbell press, Chest press (Bench press), Chin-up (Pull-up), latissimus pull (Lat pull), Push-up, Dumbbell bent-over row, Abdominal curl-up, Alternating prone extension, Squat, Dead lift, Isometric exercises, Abdominal contraction, Rowing exercise,

Text Books

1. Floyd RT. (2018). *Manual of Structural Kinesiology (20th Edition)*. Mc Graw Hill Education.
2. Lippert L. (2011). *Clinical kinesiology and anatomy (5th Edition)*. F. A. Davis Company.
3. Joseph Hamill, Kathleen M. Knutzen, Timothy R. Derrick, (2015), *Biomechanical Basis of Human Movement* (4th edition); Lippincott Williams & Wilkins, USA.
4. Hay, James G. and Raid J. Gavin, (1988), *Anatomy, Mechanics and Human motion* (2nd Edition), Prentice Hall, USA.
5. Kreighbaum, Ellen and Barthels, (1990), *Biomechanics – A qualitative Approach for studying Human movement* (3rd Edition), MC Millan Publishing Company, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	To recall the structure, function of the musculoskeletal system and appreciate the roles of muscles, bones, and joints in human movement.
CO2	Understanding of human movement and Sports movements biomechanically.
CO3	Application of mechanics with respect to human movements possible at selected joints of the skeletal system.
CO4	To analyze an exercise to determine the joint movements and positions, the specific muscles involved and their contraction types in accomplishing those movements, and/or maintaining those positions
CO5	Evaluate the importance of strength and flexibility of the muscles to perform actions without injury and enhance sports performance and also create analysis of movements for basic exercises performed by athletes.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBP103: Practical – I Fundamental Assessment in Sports Biomechanics	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
I		-	-	10	5	25	75	100

Learning Objective (LO):

LO1	To gain depth of knowledge regarding the fundamental problems experienced on play field and to arrive solution
LO2	To providing a hands-on learning experience such as in measuring kinematic and kinetic data, etc
LO3	To review the anatomy of the Musculo skeletal system and movements associated with muscles and joints
LO4	To showcase the knowledge of finding solution to problem through statistical application
LO5	Simplifying and accurately analysing result using SPSS. Exercises

a. Fundamental Assessment in Sports Biomechanics
(Any ***One*** Test)

1. Linear kinematic analysis of a 50m and 400m sprint
2. Linear kinematic analysis of a 15m sprint
3. Calculating stride length and stride frequency
4. Identifying difference in vertical jump performance that recorded between countermovement jump and squat jump
5. Determination of reactive strength index in rebound vertical jump
6. Determining the eccentric utilization ratio
7. BOSCO test – Estimation of power endurance in vertical jumping
8. Analysis of force generated in a jump
9. Determination of human power output in stair climbing
10. Determination of take-off distance, flight distance and landing distance in standing long jump.
11. Range of Motion measurement – IMU and Goniometer
12. Free body diagram
13. Upper Extremity – Muscle and their actions (shoulder, elbow, wrist, and fingers), Identifying muscles during sports movements
14. Lower Extremity – Muscle and their actions (Hip, Knee, Ankle, and Foot), Identifying muscles during sports movements
15. Trunk - Muscle and their actions, Identifying muscles during sports movements
16. Calculating foot arch and assessing variety of injury with respect to foot position and loading.

b. Statistics with SPSS and Microsoft Excel
(Any ***One*** Test)

1. To prepare the class intervals & write the frequencies by using the tally counts.
2. Computation of Correlation matrix.
3. Calculation of partial correlation.
4. Calculation of multiple correlations.

5. Calculation of t- ratio for related and unrelated groups.
6. Calculation of Z- ratio for testing the hypothesis.
7. Preparing the Percentile Scale.
8. Calculation of Chi-Square.
9. Calculation of the One Way ANOVA with equal & unequal sample sizes

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Analyse both kinematics and Kinetic in static and dynamic condition
CO2	Provide a hands-on learning experience and understand the basic concepts and applications of mechanics on playfield and also identifies solution and create new models
CO3	Determine simple biomechanical parameters relating to human movement
CO4	Demonstrate a range of competencies including general transferable skills and technical skills associated with functional anatomy and biomechanics in the laboratory setting
CO5	Hands on training with SPSS to enhance their skill

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Elective – 1 (Discipline Centric)
(Select any *one*)

Semester	23MSBE104: Biomechanics of Biological Materials	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
I		2	-	2	3	25	75	100

Learning Objective (LO):

LO1	The main goal of this course is to learn the constituent and features of bone, cartilage, tendon, ligament, peripheral nerve, spinal nerve and skeletal muscle during normal and after injury.
LO2	To explain the mechanical behaviours of bone, cartilage, tendon, ligament, peripheral nerve, spinal nerve and skeletal muscle.
LO3	To link the comprehensive knowledge of tissue adaptation to its environment with tissue biomechanical function.

Unit 1 - Biomechanics of Bone
Biomechanics of Bone – Bone composition and structure, Biomechanical properties of bone – Biomechanical behaviour of bone, bone behaviour under various loading modes (tension, compression, shear, bending, torsion, combined loading), influence of muscle activity on stress distribution in bone, strain rate dependency in bone, fatigue of bone under repetitive loading, influence of bone geometry on biomechanical behaviour, bone remodelling, degenerative changes in bone associated with aging.

Unit 2 - Biomechanics of articular cartilage
Biomechanics of articular cartilage – composition and structure of articular cartilage, biomechanical behaviour of articular cartilage, lubrication of articular cartilage, wear of articular cartilage, hypotheses on the biomechanics of carriage degeneration, functional tissue engineering of articular cartilage.

Unit 3 - Biomechanics of tendon and ligament
Biomechanics of tendon and ligament – composition and structure of ligaments, biomechanical properties of tendon and ligaments, factors that affect the biomechanical properties of tendons and ligaments - diabetes and mellitus, connective tissue disorder, renal diseases, steroids, NSAIDs, fluoroquinolones.

Unit 4 - Biomechanics of peripheral nerves and spinal nerves
Biomechanics of peripheral nerves and spinal nerves – anatomy and physiology of peripheral nerves, anatomy physiology of spinal nerves, biomechanical behaviour of peripheral nerves, biomechanical behaviour of spinal nerves, biomechanical behaviour of spinal nerve roots, nerve injury and pain.

Unit 5 - Biomechanics of skeletal muscle
Biomechanics of skeletal muscle – composition and structure of skeletal muscle, molecular basis of muscular contraction, mechanics of muscle contraction, force production in muscle, muscle fiber differentiation, muscle remodeling.

Text Books

1. Nordin, M. and Frankel, V.H. (2003) Basic Biomechanics of the Musculoskeletal System. 4th Edition, Lippincott Williams & Wilkins, New York.
2. Hay, James G. (1993), *The Biomechanics of Sports Techniques* (4th Edition), Prentice Hall, USA.
3. Kreighbaum, Ellen and Barthels, (1990), *Biomechanics – A qualitative Approach for studying Human movement* (3rd Edition), MC Millan Publishing Company, USA.
4. Mc. Ginnis, Peter M., (2005), *Biomechanics of Sport and Exercise* (2nd Edition), Human Kinetics Publishers, USA.

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the constituent and modification of biological materials during normal and after injury.
CO2	Analyse the key relationships between the application of external or internal load with load bearing tissues such as bone, cartilage, tendon, ligament, peripheral nerve, spinal nerve and skeletal muscle.
CO3	Demonstrate basic understanding of biological materials to human movement biomechanically.
CO4	Evaluate the different aspects of kinematics and kinetics of biological materials in relation to sport and exercise movements
CO5	Analyse the importance of strength and flexibility of the biological materials to perform actions without injury and enhance sports performance.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	2	3	3	2	3	3	3	3	3	3	3
CO2	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	2	3	3	3	3	2	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBE105: Orthopaedic Biomechanics	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
I		2	-	2	3	25	75	100

Learning Objective (LO):

LO1	The objective of this course is to allow students to learn the fundamental concepts of orthopaedic biomechanics.
LO2	This also integrate engineering concepts in statics, dynamics, materials, and structural analysis to examine the mechanical behaviour of the skeletal system.
LO3	Identify and analyse problems of the musculoskeletal system where sports biomechanist can make a significant contribution.

Unit 1 - Introduction to orthopaedic biomechanics

Introduction to orthopaedic biomechanics, Force, Moment of a force, Static analysis, Static analysis applied to the musculoskeletal system, Simple machine, Simple machines in the musculoskeletal system, Stress and strain, Stress–strain curve, Mechanical properties, Viscoelastic properties of materials.

Unit 2 - Orthopaedic biomaterials and their properties

Orthopaedic biomaterials and their properties, Structure and properties of materials, Metals, Alloys, Metals in orthopaedics, Ceramics, Ceramics in orthopaedics, Polymers, Polymers in orthopaedics, Composites, Composites in orthopaedics, Bone I, Bone II.

Unit 3 – Modes of loading in the musculoskeletal system

Modes of loading in the musculoskeletal system, Introduction, Compression and tension, Bending I, Bending II, Torsion, Material and geometric properties of long bones.

Unit 4 – Biomechanics of fracture

Biomechanics of fracture, Fundamentals of fracture, Mechanism of bone fracture, Patterns of bone fractures I, Patterns of bone fractures II, Patterns of bone fractures III, Stress raisers, Corrosion, Biological process of bone fracture healing, Biomechanical process of bone fracture healing.

Unit 5 - Biotribology

Biotribology, Introduction to biotribology, Friction, Wear, Lubrication I, Lubrication II, Lubrication of synovial joints, Lubrication of prosthetic joints.

Textbook

1. Sheraz S. Malik and Shahbaz S. Malik. (2015). Orthopaedic biomechanics made easy. Cambridge University Press, UK.
2. Mow, Van C.; Huiskes, Rik (2005). Basic Orthopaedic Biomechanics and Mechano-Biology (3rd Edition), Lippincott Williams & Wilkins, Philadelphia, USA.
3. Beth A. Winkelstein (2013). ORTHOPAEDIC BIOMECHANICS, CRC Press Taylor & Francis Group, USA

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Apply and Understand engineering analysis technique to orthopaedic biomechanics problems.
CO2	Material properties of bone and soft tissues from micro level to macroscopic level.
CO3	Mechanical considerations in the selection or development of surgical procedures and implanted orthopaedic devices.
CO4	Techniques used to assess the performance of joint replacement
CO5	Evaluate the Strength and weakness of total joint replacement design

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	2	3	3	3	3	2	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Elective – 2 (Generic)
(Select any *one*)

Semester	23MSBE106: Research Methodology and Statistics	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
I		2	-	2	3	25	75	100

Learning Objective (LO):

LO1	Study about the research processes
LO2	To study about the literature search and presentation
LO3	To study about the preparation of research proposal and dissertation
LO4	To study about the various statistical techniques
LO5	Hands on training with excel and SPSS

Unit 1 – Introduction

Nature and Characteristics of Research Process; Scientific & Unscientific methods, Types of Research: Basic & Applied, Quantitative &Qualitative Research, Nature and Type of Data, Measures of Central Tendency & Measures of Dispersion, Concept of Standard Error of Estimates, Graphical Representation of Data, Ethical Issues in Research

Unit 2 – Developing the Problem and Review of Related Literature

Identifying the Research Problem, Meaning and Formulation of Research Hypothesis, Delimitations and Limitations, Needs of Significance of the Study, Need, Purpose, Kinds and Steps of Literature Review, Methods of Data Collection- Participants, Variables & Instruments Selection, Research Design

Unit 3 – Statistical Analysis

Parametric & Non-Parametric Correlation; Partial & Multiple Correlation, Chi- Square Test, Normal Distribution, Properties of Normal Curve, Skewness & Kurtosis, Areas of application, Procedure of Testing of Hypothesis; Region of Acceptance & Rejection; null & alternative Hypotheses: Level of Significance, Type I & Type II errors, one tailed & two tailed hypothesis and Tests. Developing norms in the form of grading, Percentile Scale, T-Scale, Scales based on difficulty ratings.

Unit 4 – Inferential Statistics

Student t-distribution, ANOVA, ANCOVA & Post- hoc Tests – LSD & Scheffe s test, Data Analysis in Qualitative Research, Excel and SPSS.

Unit 5 – Writing a Proposal and Thesis

Thesis and Dissertation Format, Writing of abstract and Research Proposal, Presentation of Research Report, Plagiarism: Copyright violations, Tools to identify Plagiarism, Constitution of Institutional review Board, Ethical Committee Clearence.

Text Books

1. Best W. John, (1981), *Research in Education*, Prentice Hall of India Private Limited, New Delhi.

2. Bose N.M., (2005), *Research Methodology*, Sher Niwas Publication, India.
3. Malesh L.M., (1994), *Methodology of Research in Physical Education & Sports*, Metropolitan Publishers, New Delhi.
4. Thomas R. Jerry, Nelson. Taek, (2001), *Research Method in Physical Activity*, Human Kinetics, USA.
5. Clark H. David, Clarke Harrison H, (1970), *Research Process is Physical Education Recreation and Health*, Prentice Hall Inc., USA.
6. Verma J.P. (2013), *Data Analysis in Management with SPSS Software*, Springer, UK.
7. Arun Arthur & Arwn. N. Elaine, (1999), *Statistics for Psychology*, Prentice Hall, USA.
8. Write E. Susan, (1995), *Social Science Statistics*, Allyn and Bacon INC., USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Demonstrate Knowledge of research processes (reading, evaluating, and developing).
CO2	Understand Literature reviews using print and online data base
CO3	Analyses and Interpret data using Excel & SPSS for statistical calculation
CO4	Evaluate results using parametric and non parametric statistics.
CO5	Potential enough to write research proposal, research article and thesis

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO2	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	2	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO4	2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO5	3	3	3	2	3	2	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBE107: Advanced Kinematics and Dynamics	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
I		2	-	2	3	25	75	100

Learning Objective (LO):

LO1	To provide a comprehensive understanding of the principles of dynamics of rigid bodies and no rigid body systems
LO2	An introduction to ideas of stability, and to develop an ability to analyze such systems.
LO3	This course builds on the basic understanding of topics learnt in the fundamental courses in kinematics and dynamics, and provides an in-depth understanding of selected advanced topics in the area of three-dimensional kinematics, three dimensional dynamics as well as flexible body dynamics.

Unit 1
Coordinate systems, Kinematics of particles, rotating frames, relative motion; Kinetics of particles, cyclonic circulation, Foucault pendulum;

Unit 2
Integrals of Newton's second law, angular momentum, conservation laws; Impact, Newton's law of gravitation and tidal dynamics; Systems with variable mass, systems with flow.

Unit 3
Dynamics of rigid bodies, Newton-Euler equations; Dynamics of tops, gyroscopes and boomerangs; Rotation matrix and its parametrization, geometry of rotation.

Unit 4
Introduction to analytical dynamics, configuration space, constraints, generalized coordinates and forces; Hamilton's principle, Lagrange's equation of motion, constraint forces.

Unit 5
Generalized momentum, cyclic coordinates and conservation laws; Symmetry and Noether's theorem, Hamiltonian and its conservation.

Text Books

1. Anirvan DasGupta. ADVANCED DYNAMICS. Mechanical Engineering IIT Kharagpur.
2. Hay, James G. (1993), *The Biomechanics of Sports Techniques* (4th Edition), Prentice Hall, USA.
3. Kreighbaum, Ellen and Barthels, (1990), *Biomechanics – A qualitative Approach for studying Human movement* (3rd Edition), MC Millan Publishing Company, USA.
4. Mc. Ginnis, Peter M., (2005), *Biomechanics of Sport and Exercise* (2nd Edition), Human Kinetics Publishers, USA.
5. Nordin, M. and Frankel, V.H. (2003) Basic Biomechanics of the Musculoskeletal System. 4th Edition, Lippincott Williams & Wilkins, New York.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand and apply linear and angular momentum, and energy, conservation.
CO2	Appraise the importance of nonlinear interaction and dynamics in everyday systems and consequences for their analysis and design.
CO3	Combine computational with theoretical analysis techniques to solve advanced problems in dynamics.
CO4	Formulate models of dynamic systems using a variety of different approaches based on Newtonian theory and Analytical Dynamics
CO5	Interpret the knowledge provided in the course to model both common and complex mechanical systems.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	2	3	3	3	3	3	3	3	3	3
CO2	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	2	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO5	3	3	3	2	3	2	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBC201: Measurement Techniques in Biomechanics	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		4	1		5	25	75	100

Learning Objective (LO):

LO1	To study about cinematography and video analysis of two and three dimension
LO2	To study about the force platform and application of force measurement in sports biomechanics
LO3	To study about EMG in detail
LO4	To study about other techniques for the analysis of sports movements

Unit 1 – Cinematography and video analysis

The use of cine and video analysis in sports biomechanics Introduction, Levels of biomechanical analysis of sports movements, Recording the movement, Cine or video, Recording the image—cameras and lenses, Displaying the image—cine projectors and video players, Obtaining body coordinates, Two-dimensional or three-dimensional analysis, Problems and sources of error in motion recording

Unit 2 – Experimental Procedure

Two-dimensional recording procedures, Three-dimensional recording procedures, Data processing, Data smoothing, filtering and differentiation, Body segment inertia parameters, Segment orientations, Data errors

Unit 3 – Force platforms and external force measurement

Introduction and equipment considerations, General equipment considerations, The detector-transducer, Signal conditioning and recording, Operational characteristics of a force platform system Experimental procedures, Calibration, Data processing, Examples of the use of force measurement in sports biomechanics

Unit 4 – Electromyography

Introduction, Experimental considerations, Recording the myoelectric (EMG) signal EMG electrodes, Cables, EMG amplifiers, Recorders, Experimental procedures, Data processing, Temporal processing and amplitude analysis (time domain analysis), Frequency domain analysis, EMG and muscle tension, Isometric contractions, Non-isometric contractions

Unit 5 – Other techniques for the analysis of sports movements

Single-plate photography, Automatic tracking opto-electronic systems, Electrogoniometry, Accelerometry, Pressure measurement, Measurement of muscle force and torque, Direct measurement of muscle force, Isokinetic dynamometry

Text Books

1. Paul Grimshaw *et al*. (2007), *Sports & Exercise Biomechanics*, Taylor & Francis, UK.
2. Susan J. Hall, (2004), *Basic Biomechanics*, McGraw Hill Education, UK.
3. Peter McGinnis, (2005), *Biomechanics of Sport and Exercise*, Human Kinetics, USA.

4. Kathryn Lutgens *et al*. (1992), *Kinesiology (Scientific Basis of Human Motion)*, Brown and Bench, USA.
5. Roger Bartlett, (2007), *Introduction to Sports Biomechanics Analyzing Human Movement Patterns*, Routledge, UK.
6. Knudson, Duane V. (2007), *Fundamentals of biomechanics*, Springer, Germany.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Confidence to handle state of art measurement devices for biomechanical testing
CO2	To plan, prepare, measure and analyse biomechanical experiments
CO3	To apply theoretical understanding and practical knowledge to specialized case studies
CO4	To evaluate state of the art biomechanical diagnostics in competitive sports as well as in recreation, rehabilitation and health scenarios
CO5	To create reasoned diagnostics / experimental studies for competitive sports and sports products

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	2	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBC202: Neuromechanics of Human Movement	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		4	1		5	25	75	100

Learning Objective (LO):

LO1	To introduce the neural system responsible for generation of human movements.
LO2	To introduce neural control of movements (principles and theories)
LO3	Briefly introduce topics of motor disorders and rehabilitation approaches

Unit 1 - Features of movement production system
Muscles, Neurons, Neuronal pathways, Sensory, receptors, Reflexes and its kinds, Spinal control mechanisms. Major brain structures responsible for movement generation: Motor Cortex (including a discussion of premotor and supplementary motor areas), Basal Ganglia, Cerebellum, Descending and ascending pathways

Unit 2 - Control theory approaches to motor control
Force control, generalized motor programs, muscle activation control, Merton's servo hypothesis, optimal control (including Posture based movement control). Physical approaches to motor control: Mass-Spring models, Threshold control, Equilibrium point hypothesis, Referent configurations

Unit 3 - Coordination of human movement
Approaches to studying coordination: Optimization, Dynamical systems approach, Synergies, Action-Perception interactions and coupling.

Unit 4 - Exemplary behaviours
Prehension, postural control, locomotion, Kinesthesia. Changing and Evolving behaviors: Changes to movement control due to fatigue and aging.

Unit 5 - Motor disorders (introduction only)
Spinal cord injury and Spasticity, Cortical disorders (Examples: Stroke, Cerebral Palsy), Disorders of Basal Ganglia (Examples: Parkinson's disease, Huntington's disease), Cerebellar disorders (Ataxia, Tremor, Timing issues, problems with error correction). Approaches to rehabilitation (Example: Deep Brain Stimulation in Parkinson's patients).

Text Book:

1. Neurophysiological basis of movement (2 ed), Mark Latash, Human Kinetics, 2008
2. Fundamentals of Motor control Mark Latash, Academic Press (Elsevier) (2012)
3. Progress in Motor Control: A Multidisciplinary Perspective (Advances in Experimental
4. Medicine and Biology) (No. 5), Dagmar Sternad (ed), Springer (2007)
5. Neuroscience (5 ed), Dale Purves et al, Sinauer Associates (2011)
6. Human Motor Control (2 ed), David Rosenbaum, Academic Press (Elsevier) (2009)
7. Principles of neural science (5 ed), Eric Kandel, James Schwartz et al (2012)

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	The student will gain a detailed understanding of the movement producing structures in human body.
CO2	The student should understand how forces control human movement.
CO3	The student should understand coordination of human movement.
CO4	The student should gain a detailed understanding prehension, postural control, locomotion, Kinesthesia, and also understand the changes of movement occur due to fatigue and aging.
CO5	Understand the motor disorder that affect human movement.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										**Level of Correlation between PSO's & CO's**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBP203: Practical - II Biomechanical Evaluation of Sports Movements	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II				10	5	25	75	100

Learning Objective (LO):

LO1	To introduce the underlying concepts of 2D or 3D motion analysis of linear and angular movement
LO2	Examine the electrical activity produced by skeletal muscle using EMG – Kinetic data
LO3	To examine force produced during movement
LO4	Measuring strength and weakness of muscular strength using Dynamometer in athletes
LO5	How Performance Analysis is utilized in a sporting context
LO6	To provide the knowledge of various measurements to estimate physique and body composition
LO7	To provide clear information about the length, width and girth measurements of bone and muscles helps to fix markers for motion analysis

Part I: Assessment of Force and Spatiotemporal parameters
(Any *One* Test)

1. 2D/3D Analysis of Sports Skills using Kinovea software
2. EMG
3. Force estimation
4. Isokinetic testing – lower and upper extremity

Part II: Assessment of Match Analysis
(Any *One* Test)

1. Manual and Video Notation analysis
2. Work Rate Analysis and Time Motion Analysis

Part III: Assessment of Body Composition and Physique

(Any *One* Test)

1. Height, weight, body composition etc.
2. Somatotype
3. Skinfold measurements
4. Lengths and breadths of the bone
5. Girths of the muscles

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Show knowledge of kinematics and Kinetic analysis of movement in static and dynamic conditions
CO2	Determine force and strength of the muscle and relating to human movement
CO3	The application of Performance Analysis to the coaching process and the implications for training and competition
CO4	Evaluate physiological stress imposed during a match and its influence on their performance.
CO5	Safely and effectively use instrumentation and equipment to assess and record human anthropometry, physique and somatotype

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Elective – 3 (Discipline Centric)
(Select any *one*)

Semester	23MSBE204: Biomechanics of Human Joints	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		2	1		3	25	75	100

Learning Objective (LO):

LO1	The main goal of this course is to learn various types joints and their movements.
LO2	Briefly introduce biomechanics of the shoulder, elbow, wrist, hand, hip, knee, foot, ankle, lumbar and cervical spine.
LO3	To link the comprehensive knowledge of joint motion with sports performance.

Unit 1 - Biomechanics of the hip and knee

Hip - Anatomic Considerations, The Acetabulum, The Femoral Head, The Femoral Neck, The Hip Capsule and Muscles Surrounding the Hip Joint. Kinematics Range of Motion in Walking Impact of Age on Range of Motion Kinetics Indirect Measurement of Joint Forces Direct Measurement: Using Surgical Implants Joint Reaction Force During Activities Impact of Gender on Hip Kinetics Implants Effect of External Support on Hip Joint Reaction Force.

Knee - Kinematics Range of Motion Surface Joint Motion Tibiofemoral Joint Patellofemoral Joint Kinetics Statics of the Tibiofemoral Joint Dynamics of the Tibiofemoral Joint Forces in the Knee In Vivo Stability of the Knee Joint Function of the Patella

Unit 2 - Biomechanics of the foot and ankle

Structural Organization of the Foot and Ankle Rearfoot, Midfoot, Forefoot The Medial Longitudinal Arch Soft Tissues of the Foot Kinematics of the Foot and Ankle Terminology Ankle Joint Subtalar Joint Transverse Tarsal Joint The Relationship between the Transverse Tarsal Joint and the Subtalar Joint Intertarsal and Tarsometatarsal Joints Pronator and Supinator Twists of the Forefoot, Metatarsophalangeal Joint Interphalangeal Joint Passive Stability of the Ankle and Foot Muscle Control of the Ankle and Foot. Foot and Ankle Motion during Gait Muscle Action during Gait Kinetics of the Ankle Joint Statics Load Distribution Dynamics Kinetics of the Foot Effects of Shoe Wear on Foot/Ankle Biomechanics

Unit 3 - Biomechanics of the lumbar spine and cervical spine

The Motion Segment: The Functional Unit of the Spine The Anterior Portion of the Motion Segment The Posterior Portion of the Motion Segment The Ligaments of the Spine Kinematics Segmental Motion of the Spine Range of Motion Surface Joint Motion Functional Motion of the Spine The Muscles Flexion and Extension Lateral Flexion and Rotation Pelvic Motion Kinetics Statics and Dynamics Statics Dynamics Mechanical Stability of the Lumbar Spine Intra-abdominal Pressure Trunk Muscle Co-contraction External Stabilization

Cervical - Component Anatomy and Biomechanics Anatomy Osseous Structures Intervertebral Discs Mechanical Properties Vertebrae Intervertebral Discs Ligaments Muscle Neural Elements Kinematics Range of Motion Surface Joint Motion Coupled Motion of the Cervical Spine Atlantoaxial Segment Subaxial Spine Abnormal Kinematics Spinal Stability Occipito atlanto axial Complex Subaxial Cervical Spine Applied Biomechanics Decompression Arthrodesis Cervical Spine Fixation Biomechanics of Cervical Trauma Airbag Injuries Whiplash Syndrome

Unit 4 - Biomechanics of the shoulder and elbow

Shoulder - Kinematics and Anatomy Range of Motion of the Shoulder Complex Sternoclavicular Joint Acromioclavicular Joint Clavicle Glenohumeral Joint and Related Structures Glenoid Labrum Joint Capsule Glenohumeral and Coracohumeral Ligaments Additional Constraints to Glenohumeral Stability Scapulothoracic Articulation Spinal Contribution to Shoulder Motion Kinetics Muscular Anatomy Integrated Muscular Activity of the Shoulder Complex Forward Elevation External Rotation Internal Rotation Extension Scapulothoracic Motion Loads at the Glenohumeral Joint The Biomechanics of Pitching

Elbow - Anatomy Kinematics Carrying Angle Elbow Stability Kinetics Electromyography Elbow Joint Forces Articular Surface Forces Calculation of Joint Reaction Forces at the Elbow

Unit 5 - Biomechanics of wrist and hand

Anatomy of the Wrist and Hand Wrist Articulations Hand Articulations Arches of the Hand Nerve and Blood Supply of the Wrist and Hand Control of the Wrist and Hand Passive Control Mechanisms Bony Mechanisms Ligamentous Mechanisms Tendinous Mechanisms Active Control Mechanisms Muscular Mechanisms of the Wrist Muscular Mechanisms of the Hand Kinematics Wrist Range of Motion Flexion and Extension Radial and Ulnar Deviation Dart Thrower's Motion Forearm Pronation and Supination Digital Range of Motion Fingers Thumb Functional Wrist Motion Interaction of Wrist and Hand Motion Patterns of Prehensile Hand Function

Text Books

1. Nordin, M. and Frankel, V.H. (2003) Basic Biomechanics of the Musculoskeletal System. 4th Edition, Lippincott Williams & Wilkins, New York.
2. Hay, James G. (1993), *The Biomechanics of Sports Techniques* (4th Edition), Prentice Hall, USA.
3. Hay, James G. and Raid J. Gavin, (1988), *Anatomy, Mechanics and Human motion* (2nd Edition), Prentice Hall, USA.
4. Kreighbaum, Ellen and Barthels, (1990), *Biomechanics – A qualitative Approach for studying Human movement* (3rd Edition), MC Millan Publishing Company, USA.
5. Mc. Ginnis, Peter M., (2005), *Biomechanics of Sport and Exercise* (2nd Edition), Human Kinetics Publishers, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Describe the constituent and modification of joint during normal and after injury.
CO2	Know the key relationships between external or internal load with load bearing bones and joints.
CO3	Demonstrate basic understanding of joint motion to human movement biomechanically.
CO4	Know the different aspects of kinematics and kinetics of joint motion in relation to sport and exercise movements
CO5	Understand the importance of strength and flexibility of the joint to perform actions without injury and enhance sports performance.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3
	Weightage										15	15	15	15	15
	Weighted Percentage of Course Contribution to PSO's										3.0	3.0	3.0	3.0	3.0

Semester	23MSBE205: Biomechanics of Asanas	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		3			3	25	75	100

Learning Objective (LO):

LO1	Understand how biomechanics can be used in yoga perspective
LO2	Understand the use of theoretical and practical biomechanical methods that is commonly used within yoga

Unit 1

Yogasanas, history and need and importance of asanas and types of asanas - Suryanamskar, Stages of asanas, Chakra, Types of chakra, Benefits of Chakras, Yoga basics, Types of Yoga, Benefits of yoga & asanas, Yoga mudra, Types of Mudra, Benefits of mudras, Eight stages of yoga, Yama, Niyama, Asana, Pranayama, Prathyakara, Dharana, Dyana, Samadhi

Unit 2

Techniques of biomechanics of standing and twisting asana are Artha Chandrasan (Half-moon), Bhekasan (Frog), Chakrasana (Wheel), Gomukshana (Cow faced pose), Hanumasana (Monkey pose), Makrasana (Crocodile), Parvottanasana (Intense stretch to side), Salamba sarvangasana (Shoulder stand), Simhasana (Lion), Ustrasana (Camel), Virabadrasana & rkasana (Tree)

Unit 3

Technique of biomechanics of prone and supine asana are Anatasana (Annat's pose), Janusirasasana (Headto- Knee Forward Bend), Malasana (Garland), Supta pathchadsasana (Catching the big toe supine pose), Half bow ardha dhaurasana, Jathra parivatasana (Belly twist), Ananda Balasan (Joyful baby), Supta padangustasana (Supine hand to toe) & Pavana mukthasan (Wind relieving pose).

Unit 4

Technique of biomechanics of inverted asana is Sarvankasan, Cakrasana, Pincha myurasana (Feathered peacock pose), Artha Navasana (Half boas poster), Boddha konnasana (Bound angle), Balasana (Child pose), Bhujangasan (Cobra), Dhanurasana (Bow), Garudasana (Eagle pose),Hal asana (Plough), Mayurasana (Peacock), Natarajasana (Dance or Lord), Padmasana (Lotus), Salabasana (Locust), Samasthishi (Equal stand), Savasana (Corpse pose), Tadasana (Mountain pose) & Vajrasan (Thunderbolt).

Unit 5

Yogasanas for children-technique and biomechanics – Balasana, Bhujangasana, Tadasana, Vricksasana, Salabasana, Danurasana, Utkatasana, Trikonasana, Baddha Konasana, Adho Mukha Svanasana, Ardha Chandrasana, and Uttanasana

Text Books

1. Francoise *et al*. (2006), *Yoga and Pilates for everyone*, Joanna lawrenz, USA.
2. Hall, Susan J. (2004), *Basic Biomechanics* (4th Edition), MC Graw-Hill Companies, USA.
3. Hay, James G. (1993), *The Biomechanics of Sports Techniques* (4th Edition), Prentice Hall, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Develop a better understanding of how mechanical principles influence yogic movements with health perspective
CO2	Understand each Asanas with respect to pose.
CO3	Understand the benefits of each asanas.
CO4	Evaluate the efficacy of movement and muscle contractions.
CO5	Evaluate the impact of yoga asanas in children's

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	2	3	2	3	3	3	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	3	2	3	2	3	3	3	3	3
CO4	2	3	2	3	3	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	2	2	3	3	3	3	3
	Weightage										15	15	15	15	15
	Weighted Percentage of Course Contribution to PSO's										3.0	3.0	3.0	3.0	3.0

Elective – 4 (Generic)
(Select any *one*)

Semester	23MSBE206: Essentials of Sports Performance Analysis	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		2		2	3	25	75	100

Learning Objective (LO):

LO1	The course is designed for any individuals seeking to develop knowledge across the continually growing components of Sports Performance Analysis
LO2	Sports coaches seeking to effectively integrate performance analysis into coaching practice
LO3	Students in sport and exercise subject areas, conditioning professionals, physical education teachers etc. looking to introduce analysis practices into their coaching process

Unit 1
The importance of feedback to performance – Feedback, the need for valid and reliable feedback, video feedback, presenting visual feedback to athletes, precision and timing of feedback; Performance analysis – Notational analysis, Biomechanics view of performance analysis.

Unit 2
Providing information for teaching skills in sport – The micro-cycle: coaching trial to trial, The meso-cycle: Consideration for planning a practice session, The macro-cycle: coaching for long-term development; Video based technologies, substitution of reality and performance feedback – Augmented feedback in the elite sports: true ”need” or “fashion”?, Extrinsic and intrinsic feedback in sports, Feedback, video and motor learning, Qualitative feedback and quantification of performance using video-based technologies, Modeling and learning from simulation: feedback about differences between simulated and observed performance, watching versus performing movements in virtual and real environment, video technology and temporal feedback, effective use of feedback during skill acquisition.

Unit 3
Notation analysis – the development of sports specific notation systems (hand notations), computerised notational analysis, modelling, current area of research and support, research into the methodology and theory of notational analysis; The Use of Performance Indicators in Performance Analysis – Analysis of game structure.

Unit 4
Sports analysis – Creating flow charts, levels of analysis – the team, subsidiary units and individuals; How to design simple system? How to develop a notation system – Data Collection system, Data collection system in general; Examples of Notation Systems – individual sports, Team sports.

Unit 5

Analysis of notation data: reliability – the nature of data, the depth of analysis, consistency of percentage difference calculations, processing data, visual interpretation of the data (a modified Bland and Altman plot); Qualitative biomechanical analysis of technique – phase analysis, Performance outcome, recent thoughts and development.

Text Books

1. McGarry, T; O'Donoghue, P & Sampaio, J. (2013), *Routledge Handbook of Sports Performance Analysis*, Routledge, UK.
2. O'Donoghue, P. (2014), *An Introduction to Performance Analysis of Sport*, Routledge, UK
3. Hughes, M. (2008), *The Essentials of Performance Analysis: An Introduction*, Routledge, USA.
4. Martens R. (2012), *Successful Coaching* (4th Edition), Human Kinetics, USA.
5. Hughes M., and Franks IM. (2008), *The Essentials of Performance Analysis*, Routledge, UK.
6. Magill RA. (2011), *Motor Learning: Concepts and Application*, McGraw-Hill, USA.
7. Schmidt RA, Lee TD. (2014), *Motor Learning and Performance: From Principles and to Applications* (5th Edition), Human Kinetics, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the techniques and systems used to observe and analyse the tactical and technical aspects of sporting performance
CO2	Analyse and describe sporting performance using video analysis software
CO3	Understand the statistical methods used to create performance profiles
CO4	Evaluate notational analysis and performance indicators
CO5	Interpret the performance outcomes and recommend solutions

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	2	2	2	3	2	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	2	2	3	3	3	3	3
										Weightage	**15**	**15**	**15**	**15**	**15**
										Weighted Percentage of Course Contribution to PSO's	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBE207: Sports Performance and Excellence	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		2		2	3	25	75	100

Learning Objective (LO):

LO1	The course is designed for any individuals seeking to acquire knowledge with respect to fitness requirements of different sports and the training methods that can be used to achieve a successful sporting performance.
LO2	This course also explores other factors that will be related to the success of the performer, such as the effects of psychological and lifestyle factors
LO3	This course looks at the skills behind designing effective training programmes and how to instruct people in a safe and effective manner

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Know the fitness and training requirements necessary to achieve excellence in a selected sport
CO2	Evaluate the effects of psychological factors on sports training and performance.
CO3	Knows the principles of exercise, plan session design and also plan exercise programme effectively.
CO4	Identify the physiological parameters that determine sports performance with respect to their sports.
CO5	Understand the acute and chronic adaptations of physiological systems to training.

Unit 1 – Fitness Testing and Training

Fitness and training requirements to achieve excellence in sport, Fitness training methods, Lifestyle, Assessing individual fitness levels, The effect of psychological factors on sports training and sporting performance; Practical Sport – Different types of sports; Skill, Techniques and tactics; Rules, regulations and scoring systems; Role and responsibilities of officials; Reviewing Sports Performance.

Unit 2 – Anatomy and Physiology

The skeletal system, The muscular system, The cardiovascular system, The respiratory system.

Unit 3 – Psychology for sports performance

Psychological demands of sport, the impact of motivation on sports performance, methods to develop and maintain motivation, personality and sport, aggression in sport, assessing mental skills, planning a psychological skill training programme, reviewing the training programme.

Unit 4 – Exercise and fitness instruction

Types of training, principles of training, physical fitness training programme - types of training, planning an exercise programme, conducting an exercise session, undertake a review of the exercise session and exercise programme.

Unit 5 – Effects of exercise on the body systems

The short term effects of exercise on the body system, the long term effects of exercise on the body systems, energy systems, impact of drugs in sport.

Textbook

1. Jennifer Stafford-Brown, Simon Rea, Christopher Manley. (2016). BTEC LEVEL 2 First Sport Second Edition, Hodder Education, part of Hachette UK, 338 Euston Road, London NW1 3BH

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Know the fitness and training requirements necessary to achieve excellence in a selected sport
CO2	Evaluate the effects of psychological factors on sports training and performance.
CO3	Knows the principles of exercise, plan session design and also plan exercise programme effectively.
CO4	Identify the physiological parameters that determine sports performance with respect to their sports.
CO5	Understand the acute and chronic adaptations of physiological systems to training.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

SKILL ENHACEMENT COURSE - I

Semester	23MSBS208: Kinanthropometry and Sports Performance	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		1		2	2	25	75	100

Learning Objective (LO):

LO1	To provide the knowledge of various methods of measuring body composition and physique in humans
LO2	To study about the bone length and width with respect to sports performance

Unit 1 – Anthropometry

Anthropometry – definition- history- need, scope and importance- preliminary considerations- subject- data collection- anthropometry equipment – anthropometry profile- human body composition- densiometry; under water weighing- dual energy x ray absorptiometry- skin fold method- bioelectrical impedance anthropometric model- adipose tissue –muscle - bone

Unit 2 – Anthropometric land marks

Definitions - vertex-supra sternale-epigastrale-thelion-acromiale-radiale-stliondactylion-iliocristale-iliospinale-trochanterion- tibial mediale and laterale- Heath carter somatotype methodanthropometric and photoscopic somatotype methods- definition-endomorphy-mesomorphy- ectomorphy- Anthropometric landmarks- reference land marks- marked land marks- basic measurements

Unit 3 – Skinfold measurements

Locations of skinfold sites- cheek-chin-pectoral-axilla- abdomen iliac crest supraspinale - subscapular-tricpeps-biceps-patella-mid thigh proximal calf-medial calf- waist hip ratio- body mass index- fat free index

Unit 4 – Anthropometric measurement – length and breadth measurement

Technique and procedures- **Length**-Acromiale-Radiale Length (arm), Radiale-Stylion Length (forearm), Mid-stylion-Dactylion Length (hand), Iliospinale Height (obtained height plus box height), Trochanterion Height (obtained height plus box height), Trochanterion-Tibiale Laterale Length (thigh), Tibiale Laterale Height (leg), Tibiale Mediale-Sphyrion Tibiale (tibia length), Foot length. **Breadths-**Biacromial Breadth, Biiliocristal Breadth, Transverse Chest Breadth, Anterior-Posterior Chest Depth, Biepicondylar Humerus Breadth, Wrist Breadth, Hand Breadth, Biepicondylar Femur Breadth, Ankle Breadth, and Foot Breadth

Unit 5 – Anthropometric measurement - Girth

Head Girth, Neck Girth, Arm Girth (relaxed), Arm Girth (flexed and tensed), Forearm Girth, Wrist Girth, Chest Girth, Waist Girth, Omphalion Girth (abdominal), Gluteal Girth (hip), Thigh Girth (upper), Mid-Thigh Girth, Calf Girth, and Ankle Girth. Heath carter somatotyping testing and classification procedure - report generation technique

Text Books

1. Roger Eston, (2000), *Kinanthropometry and Exercise Physiology Laboratory Manual: Tests, Procedures and Data: Volume One: Anthropometry (Volume 1)* (3rd Edition) USA.
2. Kathryn Lutgens *et al*. (1992), *Kinesiology (Scientific Basis of Human Motion)*, Brown and Bench mark, USA.
3. Zahra Hojjati Zidashti, Soheila Yavarmasroor, Kaveh Hariri Asli (2014), *Computational Modeling For Anthropometry*, Apple Academic Press, Inc, Germany.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Demonstrate greater practical skills in a range of anthropometric measurements of stature, skeletal breadths, girths and skinfolds
CO2	Record, analyse and evaluate anthropometric measurements
CO3	Safely and effectively use instrumentation and equipment to assess and record human anthropometry.
CO4	Able to use skinfold caliper and BODPOD to estimate percent body fat, lean body mass, and fat mass.
CO5	Able to measure and identify physique and prescribe training based on the Somatotype estimation.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBS209: Statistics With R	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		1		2	2	25	75	100

Learning Objective (LO):

LO1	To enable students to handle data in the R software thereby helping them to understand meaningful statistical analysis performed on the data.
LO2	To enable students to extract data, and perform basic statistical operations entailing.
LO3	Data analysis such as – data clearing, data visualization, data summarization, and regression amongst others.

Unit 1 – Data Extraction and Spread Sheet Exploration
Extraction of biomechanics data like 2D/3D, Isokinetic, IMU, EMG data from database. The student should be able to save and export the data to R – environment for further analysis.

Unit 2 – Basics of R – Language
Overview of the R language: Installing R and R studio; Using R studio; Scripts, Text editors for R, Graphical user Interfaces for R, Creating and storing R workspace, installing packages and libraries, mathematical operations. Data types in R – Numeric, Integer, Chracter, Logical, Complex, and Missing data.

Unit 3 – Data Structures in R
Vectors, Matrix Arrays, Factors, List, Data frames.

Unit 4 – Programming Fundamentals
Logical operators, conditional statement, while loop, for loop, repeat loops, creating functions in R. Reading data in R, Writing data to external files, writing a table to a file, print function.

Unit 5 – Basic Statistics and Regression
Descriptive statistics, dealing with missing data in R, Data cleaning, Exploratory data analysis, data visualization using inbuilt functions. Regression analysis using R, time series data.

Textbooks

1. Gardener M. (2018). Beginning R: The Statistics Programming Language, Wiley & Sons.
2. Sekhar SRM., *et al*. (2017). Programming with R, Cengage Learning India.
3. Arun Arthur & Arwn. N. Elaine, (1999), *Statistics for Psychology*, Prentice Hall, USA.
4. Write E. Susan, (1995), *Social Science Statistics*, Allyn and Bacon INC., USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Demonstrate greater practical skills in a range of anthropometric measurements of stature, skeletal breadths, girths and skinfolds
CO2	Record, analyse and evaluate anthropometric measurements
CO3	Safely and effectively use instrumentation and equipment to assess and record human anthropometry.
CO4	Able to use skinfold caliper and BODPOD to estimate percent body fat, lean body mass, and fat mass.
CO5	Able to measure and identify physique and prescribe training based on the Somatotype estimation.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBC301: Biomechanics of Human Gait	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
III		4	1		5	25	75	100

Learning Objective (LO):

LO1	Using evidence-based checklists for gait analysis, a clinical evaluation will be carried out objectively and scientifically of various test subjects when walking.
LO2	Fundamentals of the normal walking gait patterns is assessed.
LO3	Abnormalities in the walking patterns will be studied and also identifies the potential cause of gait abnormalities.

Unit 1 – Fundamentals and Normal Gait

Gait cycle, Reciprocal floor contact patterns, Phases of Gait, Basic functions – Body subdivision, Locomotor Functions. Normal Gait: Ankle foot Complex – Ankle, Functional Interpretation of the Ankle, The foot, Floor Contact, Foot Pressure; Knee – Motion, Vector Pattern, Muscle Control, Functional Interpretation.

Unit 2 – Normal Gait

Hip – Motion, Body Weight Vector, Muscle Control, Functional Interpretation; Head, Trunk, and Pelvis – Gait Dynamics, Vector Patterns, Muscle Control, Functional Interpretation; Arm – Gait Mechanics, Muscle Control, Functional Interpretation; Total Limb Function – Initial Contact, Loading Response, Mid Stance, Terminal Stance, Pre-Swing, Initial Swing, Mid Swing, Terminal Swing.

Unit 3 – Pathological Gait

Pathological Mechanisms – Deformity, Muscle Weakness, Sensory Loss, Pain, Impaired Motor Control; Ankle and Foot Gait Deviations – Ankle, Excessive Ankle Plantar Flexion, Foot Dysfunction; Knee Abnormal Gait – Sagittal Plane Deviations, Causes of Inadequate Knee Flexion and Excessive Extension, Inadequate Extension, Coronal Plane Gait Deviations, Causes of Coronal Plane Gait Deviations.

Unit 4 – Pathological Gait

Hip Gait Deviations - Inadequate Extension, Excessive Flexion, Causes of Inadequate Extension and Excessive Flexion, Inadequate Flexion, Causes of Inadequate Hip Flexion, Excessive Coronal Plane Motion, Causes of Excessive Adduction, Causes of Excessive Abduction, Excessive Transverse Rotation, Causes of Excessive Rotation; Pelvis and Trunk Pathological Gait; Clinical Examples – Contracture, Weakness, Control Dysfunction.

Unit 5 – Pathological Gait

Joint Immobilization, Swing through, Crutch – Assisted Gait, Spinal Cord injury, Reciprocal Gait, Myelodysplasia, Amputation, Arthritis, Hemiplegia (Stroke), Spastic Diplegia (Cerebral Palsy).

Text Books

1. Jacquelin Perry. (1992). Gair Analysis Normal and Pathological function. Slack Incorporated, NJ, USA.

2. Vaughan CL, Davis BL, O'Connor JC. (1992). Dynamics of Human Gait (2nd edition). Kiboho Publishers, South Africa.
3. Braune W, Fischer O. (1987). The Human Gait. Springer-Verlag, Berlin Heidelberg New York, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Critical analyse gait and movement using biomechanical principles.
CO2	Evaluate the qualitative and quantitative methods of biomechanical analysis of gait and movement.
CO3	Analyse, interpret, and evaluate useful data using 2D/3D motion capture, force plates, IMU, EMG, etc. equipment.
CO4	Analyse the muscle forces and loads on joints during gait using established modelling technique.
CO5	Evaluate the difference between normal and pathological gait and categorise gait through pattern recognition.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBC302: Applications of Biomechanics to Physiological Systems	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
III		4	1		5	25	75	100

Learning Objective (LO):

LO1	To provide the knowledge of mechanical concepts as applied to human physiological systems
LO2	To study about the heart, lung, and hypothalamus
LO3	To study the biomechanical application on systems that is taxed during exercise

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Develop a better understanding of how mechanical principles influence physiological systems during everyday life
CO2	Understand cardiovascular mechanics and control during exercise
CO3	Analyse the respiratory mechanics and control during exercise
CO4	Evaluate the similarity and coupling between cardiovascular and respiratory mechanics and control.
CO5	Thermal Responses, since an intrinsic part of biomechanical activities is the production of heat.

Unit 1 – Exercise Limitations

Exercise Intensity and Duration, Muscle Metabolism, Muscle Fiber Structure, Muscle Energy Sources, Oxygen Debt, Maximal Oxygen Uptake, Anaerobic Threshold, Oxygen Uptake Kinetics, Bioenergetics Model, Chemical Responses, Training, Cardiovascular Exercise Limitation, Respiratory Limitation, Thermal Limitation, Prolonged Exercise, and Variability of Responses

Unit 2 – Exercise Biomechanics

Physics of Movement, Equilibrium and Stability, Muscles and Levers, Energy and Motion, The Energy Cost of Movement, Cost of Transport, Muscular Efficiency, Walking and Running, Basic Analysis, Optimal Control of Walking, Experimental Results, Carrying Loads, Load Position, Lifting and Carrying. Biomechanical Model - Using Carts, Sustained Work, Aging and Training, Gender, Genetics

Unit 3 – Cardiovascular Responses

Cardiovascular Mechanics - Blood Characteristics, Vascular Characteristics, Heart Characteristics. Cardiovascular Control, Cardiovascular Mechanical Models, Cardiovascular Control Models, Systemic and Pulmonary Vessels, Model Performance

Unit 4 – Respiratory Responses

Respiratory Mechanics, Lung Volume and Gas Exchange, Mechanical Properties; Control of respiration – Respiratory Receptors, Respiratory Controller, Effector Organs, Exercise; Respiratory mechanical models – Respiratory Mechanics Model, Gas Concentration

Models; Respiratory control models – System Models, Fujihara Control Model, Optimization Model

Unit 5 – Thermal responses

Thermal Mechanics – Convention, Conduction, Radiation, Evaporation, and Rate of Heat Production; Thermoregulation – Hypothalamus, Heat Loss Mechanism, Heat Maintenance and Generation, Acclimatization, Circadian Rhythm, and Exercise and Thermoregulation; Thermoregulatory Model, Body temperature response – Equilibrium Temperature, Variation of Rectal Temperature with Time, Model Limitations and Performance

Text Books

1. Arthur T. Johnson. (2008), *Biomechanics and Exercise Physiology: Quantitative Modelling*, CRC press, Taylor & Francis Group, Newyork, USA.
2. Duane Knudson, (2007), *Fundamentals of Biomechanics*, Springer publication, 2nd Edition, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Develop a better understanding of how mechanical principles influence physiological systems during everyday life
CO2	Understand cardiovascular mechanics and control during exercise
CO3	Analyse the respiratory mechanics and control during exercise
CO4	Evaluate the similarity and coupling between cardiovascular and respiratory mechanics and control.
CO5	Thermal Responses, since an intrinsic part of biomechanical activities is the production of heat.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3
CO2	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
										Weightage	**15**	**15**	**15**	**15**	**15**
										Weighted Percentage of Course Contribution to PSO's	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBC303: Motor learning and control in sports	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
III		4	1		5	25	75	100

Learning Objective (LO):

LO1	The motor learning course aims to acquaint students with the dynamic set of internal processes associated with practice and experience that, articulated with the conditions of learning, instructions, and practice.
LO2	Success in the learning and performance of motor skills in distinct contexts, namely sports, school, elderly populations and populations with special needs.

Unit 1 – Introduction to motor skills and abilities

The Classification of motor skills – Application, Skills, Actions, Movements, and Neuromotor Processes, One Dimensional Classification Systems, Gentile's Two Dimensions Taxonomy; The measurement of motor performance – Application, Reaction time, Error measures, Kinematic measures, kinetic, EMG, Brain activity measures, Measuring coordination. Motor Abilities – Application, Ability and motor ability.

Unit 2 – Introduction to Motor Control

Neuromotor basic for motor control -The Neuron, The central Nervous system, The neural control of voluntary movement; Motor control theories – Theory and Professional practice, Motor Control theory, Open loop and closed loop control system, two theories of motor control, the current state of the control theory; Sensory Components of Motor Control – Touch and Motor control, Proprioception and Motor control, Vision and Motor control; Performance and motor control characteristics of functional skills – Speed-Accuracy skill, Prehension, Handwriting, bimanual coordination skills, catching a moving object, striking a moving object, locomotion;

Unit 3 – Introduction to motor control – Attention and Memory

Action preparation – Action preparation requires time, task and situation characteristics influencing preparation, performer characteristics influencing preparation, what occur during preparation?; Attention and Memory: Attention – Attention and multiple-task performance, the dual task procedure for assessing attention demands, focusing attention, attention and automaticity, visual selective attention, visual search and motor skill performance, training visual search strategies; Memory – Memory structure, working memory, long term memory, remembering and forgetting, assessing remembering and forgetting, the cause for forgetting, movement characteristics related to memory performance, strategies that enhance memory performance, Practice test context effects.

Unit 4 – Introduction to motor skill learning

Defining and assessing learning – Performance distinguished from learning, general performance characteristics of skill learning, learning assessment technique, practice performance may misrepresent learning; The stages of learning – The Fitts and Posner Three-Stage Model, Gentile's Two stage model, Bernstein's description of learning process, performer and performance changes across the stages of learning, a performer

characteristics that does not change across the stages of learning; Transfer of learning – Transfer of learning, importance of transfer of learning, positive transfer of learning, negative transfer, bilateral transfer.

Unit 5 – Instruction and Augmented Feedback / Practice Conditions

Demonstration, Verbal instructions and cues, Augmented feedback – the feedback family, types of augmented feedback, the roles of augmented feedback in skill acquisition, essential of augmented feedback, content of augmented feedback, types of knowledge of performance, timing issues related to augmented feedback, the KR Delay and Post KR intervals, frequency of presenting augmented feedback, techniques that reduces augmented feedback frequency; Practice conditions – practice variability and specificity, the amount and distribution of practice, whole and part practice, mental practice

Text books

1. Magill RA, Anderson DI. (2017). Motor Learning and Control – Concept and Application. McGraw Hill Education, NY, USA.
2. Schmidt RA, Wrisberg CA. (1941). Motor learning and Performance – A Problem Based Learning Approach, Human Kinetics, NY, USA.
3. Winter DA. (2000). Biomechanics and Motor Control of Human Movements, John Wiley & Sons, Inc, NY, USA.

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Identify the strengths and limitations of techniques to assess processes of motor learning and control.
CO2	Explain the changes in motor function or motor performance that may occur with motor learning and development across the lifespan.
CO3	Assess aspects of an individual's motor function in physical activity and exercise contexts including applying risk management and risk assessment concepts associated with the motor learning and control of exercise science.
CO4	Design motor learning environments and protocols to maximise specific motor learning and control outcomes in a range of physical activity and exercise contexts.
CO5	Apply motor learning principles and skill acquisition principles, including the effective use of learning cues and movement progressions, for teaching and correcting movement and exercise technique.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
	Weightage										15	15	15	15	15
	Weighted Percentage of Course Contribution to PSO's										3.0	3.0	3.0	3.0	3.0

Semester	23MSBP304: Practical III Applied Physiology and Biomechanical Assessment of Human Performance	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
III				10	5	25	75	100

Learning Objective (LO):

LO1	Spatiotemporal patterns of gait on sports performance
LO2	To provide the knowledge to assess various physiological systems
LO3	This paper is designed to teach the basic of MATLAB programming to the students.

Part I: Assessment of Human Gait
(Any *One* Test)

1. Step
2. Step Length
3. Step rate
4. Step Time
5. Stride

Part II: Assessment of Physiological parameters
(Any *One* Test)

1. Heart rate
2. Blood pressure
3. CPET - VO_2max
4. Lung volumes
5. Anaerobic capacity for lower extremity
6. Anaerobic capacity for upper extremity
7. Leg and Back Strength
8. Grip Strength

Part III: MATLAB
(Any *One* Test)

1. Introduction to MATLAB Programming Basics
2. Creating MATLAB Scripts and Plots
3. User Defined Functions
4. Control Flow using Loops
5. String Operations
6. 3D Plots
7. Magic Square Formations
8. Linear Algebra with MATLAB

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the significance of gait patterns
CO2	Understand the biomechanical role on physiological variables
CO3	Learns to measure physiological variables
CO4	Explains strength and weakness of the athletes to enhance their sports performance.
CO5	Students will be able to write basic programming for numerical analysis, matrix manipulation, 2D and 3D plotting using MATLAB.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										**Level of Correlation between PSO's & CO's**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBI305: Internship	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
III					2	25	75	100

Learning Objective (LO):

LO1	Internships are educational and career development opportunities, providing practical experience in a field or discipline.
LO2	This serves a meaningful and mutually beneficial to the intern and organisation.

Guidelines for Internship

Sl. No	Name	Duration	Internship	Credits
1.	Internship Assessment (Assessed in IIIrd Semester)	3 – 4 weeks (Summer vacation after 2nd Semester)	Inter (SAI, SDAT, Private Sports Organisations)	2

Exception to undertake internship

1. In case student want to pursue their family business and don't want to undergo internship, a declaration by a parent may be submitted directly to the programme coordinator and the HoD of concerned Department.

Monitoring and Evaluation of Internship

Every student is required to prepare a file containing documentary proofs of the activities done by him/ her. The evaluation of these activities will be done by Programmed Head/ Cell In-charge/ Project Head/ CPDD cell/ faculty mentor or Industry Supervisor as specified below.

Major Head of Activity	Credits (Max.) Degree	Suggested period (Max.)	Total Duration/ Week Degree	Sub Activity Head	Proposed Document as Evidence	Evaluated by	Performance appraisal/ Maximum points/ activity
Inter Internship Activities	2	Summer vacation after 2nd Semester	3 – 4 weeks	**Inter** (SAI, SDAT, Private Sports Organisations)	Certificate	Programme Coordinator / HoD	Satisfactory/ Good/ Excellent

The internship training of the students will be evaluated in three stages:

Sl. No	Evaluation	Evaluation on the Basis	Mark
1	Organisation (External)	Punctuality, eagerness to learn, Maintenance of Daily Diary and skill test in addition to any remarks.	75
2	Programme Coordinator (Internal)	Faculty Mentor of the institutes will make a surprise visit to the internship site, to check the student's presence physically, if the student is found absent without prior intimation	15
3		Seminar presentation/viva-voce at the Institute The evaluation will be based on the following criteria: • Quality of content presented. • Proper planning for presentation. • Effectiveness of presentation. • Depth of knowledge and skills. • Attendance record, daily diary, departmental reports shall also be analyzed along with the Internship Report.	10

Internship Report

a. STUDENT'S DIARY/ DAILY LOG

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students.

The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit.

Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Graphical Presentation and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

b. Internship Report

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact porogramme coorrdinator for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, CPDD and Faculty Mentor. The Internship report will be evaluated on the basis of following criteria:

i. Originality.
ii. Adequacy and purposeful write-up.
iii. Organization, format, drawings, sketches, style, language etc.
iv. Variety and relevance of learning experience.

Practical applications, relationships with basic theory and concepts taught in the course.

The following forms can be obtained from the Department office.

1. **STUDENT INTERNSHIP PROGRAMME APPLICATION FORM**
2. **Internship synopsis (Format)**
3. **Relieving letter of student (Format)**
4. **Students Daily Diary (Format)**
5. **Supervisor Evaluation of Intern (Format)**
6. **Student feedback of Internship (Format)**
7. **Proforma for evaluation of internship by programme coordinator (Format)**
8. **Internship evaluation report (Format)**
9. **Attendance Sheet**

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Will expose students to the real environment, which cannot be simulated in the classroom and hence creating competent professionals for the Sports Science organisations.
CO2	Provide possible opportunities to learn, understand and sharpen the real time technical skills required at the job.
CO3	Learn to apply the acquired knowledge in real situations.
CO4	Exposure to the current technological developments relevant to the subject area of training.
CO5	Expose the students to future employers.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Weightage										15	15	15	15	15
	Weighted Percentage of Course Contribution to PSO's										3.0	3.0	3.0	3.0	3.0

Elective – 5 (Discipline Centric)
(Select any *one*)

Semester	23MSBE306: MATLAB	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
III		3			3	25	75	100

Learning Objective (LO):

LO1	To familiarize the student in introducing and exploring MATLAB & LABVIEW software
LO2	To enable the student on how to approach for solving sports biomechanics problems using simulation tools
LO3	To provide a foundation in use of this software for real time applications
LO4	To study about motion detection, text recognition, finding particles, bouncing ball, ball tracking and microarray analysis

Unit 1 – Quick start
- Desktop basics
- Matrices and arrays
- Workspace variables
- Character strings
- Calling function
- Plots and programming scripts

Unit 2 – Language fundamentals
- Matrices and magic squares
- Expressions
- Entering commands
- Indexing
- Types of arrays

Unit 3 – Mathematics
- Linear algebra
- Operations on nonlinear functions
- Multivariate data
- Data analysis

Unit 4 – Graphics
- Basic plotting function
- Creating mesh and surface plots
- Display images
- Printing graphics
- Working with graphic objects

Unit 5 – Programming
- Control flow
- Scripts and function

Text Books

1. Krister Ahlersten, (2012), *An Introduction to MATLAB*, Bookboon Publishing, UK
2. Brian Hahn and Dan Valentine, (2013), *Essential MATLAB for Engineers and Scientists* (5th Edition), Academic Press, UK
3. Stormy Attaway, (2013), *MATLAB: A Practical Introduction to Programming and Problem Solving* (3rd Edition), Butterworth – Heinemann, UK

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	To understand the use of MATLAB in order to analyse signals and apply filters in raw data during human movement
CO2	Enhance the ability to create a MATLAB script that can read the data, improve data quality, visualize results and also analyse compute relevant signal characteristics of various signals relevant in movement science
CO3	students will learn the fundamentals of programming and problem solving for biomechanics with MATLAB
CO4	Able to generate plots and export this for use in reports and presentations.
CO5	Able to program scripts and functions using the MATLAB development environment.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	2	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBE307: Biomechanical Analysis of Human Movement	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
III		3			3	25	75	100

Learning Objective (LO):

LO1	Understand the basic sports movements performed during an activity and to avoid injury related movements through biomechanical analysis

Unit 1 – Balance, Slipping, Falling, and Landing

Balance - Aim of Standing, Mechanics of Standing, Biomechanics of Standing, Variations of Standing, Enhancement of Standing, Safety of Standing, Aim of Toppling Avoidance, Mechanics of Toppling, Biomechanics of Toppling, Variations of Toppling, Enhancement of Toppling Avoidance, Toppling Safety. Slipping, Falling, and Landing - Aim of Slipping Avoidance, Mechanics of Slipping, Biomechanics of Slipping, Variations of Slipping, Enhancement of Slipping Avoidance, Slipping Safety, Aim of Falling and Landing, Mechanics of Falling and Landing, Biomechanics of Falling and Landing, Variations of Falling and Landing, Enhancement and Safety of Falling and Landing.

Unit 2 – Walking and Running

Walking and Running - Aim of Walking, Mechanics of Walking, Biomechanics of Walking, Variations of Walking, Enhancement and Safety of Walking, Aim of Running, Mechanics of Running, Biomechanics of Running, Variations of Running, Enhancement of Running, Running Safety.

Unit 3 – Jumping & Object Manipulation

Jumping - Aim of Jumping, Mechanics of Jumping, Biomechanics of Jumping, Variations of Jumping, Enhancement of Jumping, Jumping Safety. Object Manipulation - Aim of Gripping, Mechanics of Gripping, Biomechanics of Gripping, Variations of Gripping, Enhancement and Safety of Gripping, Aim of Pulling and Pushing, Mechanics of Pulling and Pushing, Biomechanics of Pulling and Pushing, Variations of Pulling and Pushing, Enhancement and Safety of Pulling and Pushing, Aim of Lifting and Lowering, Mechanics of Lifting and Lowering, Biomechanics of Lifting and Lowering, Variations of Lifting and Lowering, Enhancement and Safety of Lifting and Lowering, Aim of Carrying, Mechanics of Carrying, Biomechanics of Carrying, Variations of Carrying, Enhancement and Safety of Carrying

Unit 4 – Throwing, Striking and Catching

Throwing, Striking, and Catching - Aim of Throwing and Striking, Mechanics of Throwing and Striking, Biomechanics of Throwing and Striking, Variations of Throwing and Striking, Enhancement of Throwing and Striking, Throwing and Striking Safety, Aim of Catching, Mechanics of Catching, Biomechanics of Catching, Variations of Catching. Enhancement of Catching , Catching Safety

Unit 5 – Climbing and Swinging

Climbing and Swinging - Aim of Climbing, Mechanics of Climbing, Biomechanics of Climbing, Variations of Climbing, Enhancement and Safety of Climbing, Aim of Swinging,

Mechanics of Swinging, Biomechanics of Swinging, Variations of Swinging, Enhancement and Safety of Swinging. Airborne Maneuvers - Aim of Airborne Maneuvers, Mechanics of Airborne Maneuvers, Biomechanics of Airborne Maneuvers, Variations of Airborne Maneuvers, Enhancement of Airborne Maneuvers, Safety in Airborne Maneuvers.

Text Books

3. Chapman, Arthur E (2008), *Biomechanical analysis of fundamental human movements*, Human Kinetics, Champaign, IL USA.
4. Hall, Susan J. (2004), *Basic Biomechanics* (4th Edition), MC Graw-Hill Companies, USA.
5. Hay, James G. (1993), *The Biomechanics of Sports Techniques* (4th Edition), Prentice Hall, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the balance, toppling, slipping, falling and landing mechanism during competitive sports
CO2	Understand the mechanism of walking, running, jumping, throwing, striking, and catching while playing sports and games
CO3	Understand the applications of Climbing, Swinging, and airborne manoeuvres in sports
CO4	Understand how the movement may be enhanced by technique or training and how safety and avoidance of injury can be largely ensured.
CO5	Display their efficiency to analyze activities of their choice biomechanically using standard tools and concepts

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
	Weightage										15	15	15	15	15
	Weighted Percentage of Course Contribution to PSO's										3.0	3.0	3.0	3.0	3.0

Skill Enhancement Course – II

Semester	23MSBS308: Technical Training in Sports Biomechanics	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		2			2	25	75	100

Learning Objective (LO):

LO1	Understand the physical parameters of movement in different types of sports and essentials for solving simple biomechanical problems in sports.
LO2	Analyse sports skills and equipped to identify and correct the errors in sports skill or movement.

Unit 1 - Analysing Sport Skills & Identifying and Correcting Errors in Sport Skills

Analysing Sport Skills & Identifying - Determine the objectives of the skill, note any special characteristics of the skill, study top-flight performances of the skill, divide the skill into phases, divide each phase into key elements, understand the mechanical reasons that each key element is performed as it is. **Correcting Errors in Sport Skills** - Observe the Complete Skill, Analyze Each Phase and Its Key Elements, Use Your Knowledge of Sport Mechanics in Your Analysis, Select Errors to Be Corrected, Decide on Appropriate Methods for the Correction of Errors.

Unit 2 - Movement of the athlete

Sprinting – Phases of sprinting, biomechanics principles application, Technique, Sprinting characteristics and Mechanical principles.

Jumping – High jump Phases, biomechanics principles application, Technique, Sprinting characteristics and Mechanical principles.

Wheelchair Sports - Biomechanics principles application, Technique, Sprinting characteristics and Mechanical principles.

Unit 3 – Movement of an implement

Throwing – Implement, Grip, Phases of javelin throwing, biomechanics principles application, Technique, throwing characteristics and Mechanical principles.

Striking and Batting – Implement, technique, phases, biomechanics principles application, striking and batting characteristics and Mechanical principles.

Swinging and Rotating – Swinging skills, phases, biomechanics principles application, swinging and rotating characteristics and Mechanical principles.

Unit 4 – Movement of an opposition

Weightlifting – Clean and jerk, Skill, biomechanics principles application, weightlifting characteristics and Mechanical principles.

Combat Throwing – Hip throw in Judo, Phases, biomechanics principles application, combat throwing characteristics and Mechanical principles.

Tackle in American football - Tackle technique in American football, Phases, biomechanics principles application, tackle in American football characteristics and Mechanical principles.

Unit 5 – Movement through a fluid

Swimming – Freestyle stroke in swimming, back crawl, butterfly, segment movements, technique, phases of the technique, biomechanics principles application, swimming characteristics and Mechanical principles.

Kicking a ball – Punt in football/soccer, kicking, magnus effect, segment movements, phases of the skill, biomechanics principles application, kicking a ball characteristics and Mechanical principles.

Paddling a Watercraft – Rowing skull, kayak, body movements, phases of movements, biomechanics principles application, paddling a watercraft characteristics and Mechanical principles.

Textbook

1. Burkett B. (2019). Applied Sports Mechanics, Human kinetics, NY, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Apply the sports mechanic principles to the common types of sports.
CO2	Transfer mechanical knowledge into technique
CO3	Break the sport into key specific phase
CO4	Identify the key components that need to be addressed when performing these sports.
CO5	Correct the errors in sports skill or movement.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	2	3	2	3	3	3	3	3
CO5	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBS309: Programming with Python	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
II		2			2	25	75	100

Learning Objective (LO):

LO1	Python is next generation multi-purpose programming language, that allows different users to create applications of various domains. Students will be able to learn primary fundamentals of python programming and potential of python is to achieve modern computing requirements.
LO2	To develop proficiency in creating based applications using the Python Programming Language.
LO3	To be able to understand the various data structures available in Python programming language and apply them in solving computational problems.

Unit 1 - Basics of Python

Python Installation and Working of it, get familiar with python variables and data types, Operator understanding and its usage, detail study of python blocks,

Unit 2 - Structure Types and mutability

Hands on with conditional blocks using if, else and elif, Hands on examples and study of looping with range, list and dictionaries. hands on to organize python code with function, modular approach in python.

Unit 3 - Exception, Testing and Debugging

Handling if exceptions to handle the code cracks, handling and helping file operations, coding with the exceptional handling and testing Anonymous method, Properties, Indexers, Exception Handling

Unit 4 - Classes and OOP Concepts

Procedural and Object-Oriented Programming, Classes and working with instances, Method overloading, Polymorphism, importing internal module as well as external modules in the code Packages understanding and their usage, hands on with Lambda function in python coding with the use of functions, modules and external packages

Unit 5 - Algorithm and Data Structure

Stack, Queue, Tree, ordered list, Introduction to Recursion, Divide and Conquer Strategy, Greedy Strategy, Graph Algorithms. Advance Topics: Regular Expression, Multi thread Programming, Security

Textbooks

1. Starting Out with Python (2009) Pearson, Tonny Gaddis
2. Beginning Pyhton Wrox Publication Peter Norton, Alex Samuel

3. Python Algorithms Apress, Magnus Liet Hetland,
4. Python Object Oriented Programming PACKT Press, Dusty Phillips
5. Python for Unix and Linux System Administration O'Relly, Noad Gift

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Identify core aspects of programming and features of the Python language
CO2	Apply various fundamentals for problem solving using python.
CO3	Use different tools for writing and running Python code
CO4	Understand and apply core programming concepts like data structures, conditionals, loops, variables, and functions
CO5	Design and write fully-functional Python programs using commonly used data structures, custom functions, and reading and writing to files

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3
CO2	3	2	3	3	3	2	3	3	3	3	3	3	3	3	3
CO3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	2	3	3	3	3	2	2	2	3	3	3	3	3
CO5	2	3	3	2	2	3	3	3	3	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBC401: Biomechanics of Footwear	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
IV		4	1		5	25	75	100

Learning Objective (LO):

LO1	Current technology to design sports footwear based on foot morphology and biomechanics
LO2	Sports footwear mechanics provide insight for runners to reduce injury risk and also to increase running performance.
LO3	Sports footwear anatomy modification on sports performance

Unit 1

The Human Foot – Foot structure and anatomy, Foot morphology, Foot characteristics and related empirical models.

Unit 2

Sports Shoes – Sports shoes, Basic of sports shoe design, Athlete feet, Sports shoe anatomy – the midsole, encapsulated midsole, The outer sole – Treads, The insole, The heel counter, the upper.

Unit 3

Footwear effects on running kinematics – Kinematics of the foot and ankle, Footwear effects of the Foot and Ankle motion, Forefoot kinematics, Torsion along the longitudinal axis of the foot, footwear effects on coordination, footwear and footfall patterns, footwear for specific types of running.

Unit 4

Footwear influence on running biomechanics – Footwear flexibility, midsole cushioning, running shoe outsole traction and durability, running shoe influence on energetics.

Unit 5

Effects of footwear on muscle function – Athletic or running shoes: Midsole elasticity/Viscosity/hardness, motion-control shoes, midsole wedging, heel counter, Rocker-sole and unstable style shoes, high-heeled shoes, negative heeled shoes. Soccer shoe design and its influence on Players performance, Footwear for preventing Acute Sports-related Ankle Ligamentous sprain injury.

Text Books

1. Goonetilleke RS. (2013). The Science of Footwear. CRC Press, Taylor and Francis, Denver, USA.
2. Easterling KE. (1993). Advanced materials for Sports Equipment. Springer-Science+Business Media, B.V. Salisbury.
3. Werd MB, Leslie Knight E, Langer PR. (2017). Athletic Footwear and Orthoses in Sports Medicine, Springer Publication.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Highlight the sport shoe anatomy with its mechanics.
CO2	Understand basic shoe design for athlete feet.
CO3	Identify the footwear effects on running kinematics
CO4	Understand the footwear influence on running biomechanics
CO5	Understand soccer shoe designing on players performance and shoes to prevent ankle related injuries.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBC402: Biomechanics of Musculoskeletal Injuries	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
IV		4	1		5	25	75	100

Learning Objective (LO):

LO1	To establish an overview of injury mechanisms, principles of injury, contributing factors to injury occurrence and rehabilitations.
LO2	To identify and explain the mechanisms involved in musculoskeletal injuries to major joints and segments of the lower extremities, upper extremities, head, neck, and trunk.

Unit 1 – Overview of Injury mechanisms

Injury, types of injuries, acute injury, chronic injuries, principles of injury, Contributory factors, Rehabilitation.

Unit 2 – Hip, Thigh, and Knee Injuries

Hip fracture, Classification and causes, Risk and prevention in older persons: Hip dislocation, Hip Osteoarthritis; Thigh injuries – Quadriceps Contusion, Myositis Ossificans, Femoral fracture, Hamstring Strain, Knee injuries – Posterior Cruciate Ligament Injury, Anterior Cruciate Ligament Injury, Meniscus Injury, Collateral Ligament Sprain, Knee Extensor Disorders.

Unit 3 – Lower Leg Injuries

Compartment Syndrome, Medial Tibial Syndrome, Tibial Stress Reaction and Stress Fracture, Traumatic Fractures of the Tibia and Fibula; Ankle and Foot Injuries – Ankle Sprain, Calcaneal Tendon Pathologies, Plantar Fasciitis, Toe Injuries.

Unit 4 – Shoulder, Elbow and Wrist injuries

Shoulder injuries, Acromioclavicular sprain, Glenohumeral instability and dislocation, Rotatory Cuff Pathologies, Glenohumeral Impingement, Rotator Cuff Rupture, Labral Pathologies; Upper - Arm Injuries – Humeral Fracture, Biceps Tendon Injuries; Elbow Injuries – Epicondylitis – Lateral Epicondylitis, Medial Epicondylitis, Valgus – Extension Loading Injuries, Elbow Dislocation, Elbow Fractures; Forearm Injuries – Diaphyseal Fractures of the Radius and Ulna, Fracture of the Distal Radius, Ulnar Variance; Wrist and Hand Injuries – Carpal Tunnel Syndrome, Carpal Fractures, Thumb Injuries, Metacarpal and Phalangeal Conditions.

Unit 5 – Head, Neck and Trunk Injuries

Head injuries, Principles of head injury – Traumatic Brain Injury, Mechanics; Skull fracture; Cerebral Contusion, Brain Swelling, Concussion, Diffuse Axonal Injury, Penetrating injuries, facial fracture, Neck injuries – Cervical trauma Spinal cord injury, Whiplash-related injuries, cervical spondylosis; Trunk injuries – Vertebral fracture, Spinal deformities, Scoliosis, Kyphosis, Lordosis. Spondylosis and Spondylolisthesis, Intervertebral Disc Pathologies.

Text Books

1. White, AA and Panjabi, MM, (1978), *Clinical Biomechanics of the Spine* (3rd Edition), J. B. Lippincott Company, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Gain the knowledge of injury mechanisms and factors that contribute to injury occurrence.
CO2	Able to differentiate the Injuries along with their treatment.
CO3	Describe the Injury due to the possible mechanical error and able to recommend the exercise based on mechanics.
CO4	Critically analyse human movement and able to identify normal and abnormal movement patterns performed by the athletes.
CO5	Impart rehabilitation exercise to sports injuries with assistance of therapist.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBD403: Dissertation	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
IV				14	7	25	75	100

Learning Objective (LO):

LO1	Investigating current research problem and finding solution

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Handle the practical problems to enhance the sports performance
CO2	Collect literature related to their research problem
CO3	Knows the methods to collect data
CO4	Knows the suitable statistics and able interpret the study result
CO5	Identifies the reason for modification and concludes

(Submission of Dissertation)

Student must design, conduct, and report on an original research study of an aspect of their M.Sc. Sports Biomechanics programme. They can perform research using isokinetic, Inertial Measurement Unit for kinematic measurements or kinetic measurements of a skill or sports movement on their respective sports or games of their choice and in the area of Performance analysis in team and individual sports or games.

The student must carry out a research work based on topic of his/her own choice, under the supervision of a teacher. The research work shall be by the fourth semester. The students must plan and prepare a research proposal and make an initial synopsis presentation wherein he/she introduces the problem, its relevance, the method, expected outcome etc., and internal evaluation of the presentation will be made. The supervising teacher will monitor the student's progress in the study which will be evaluated internally. The final project report has to be submitted in the prescribed format (APA Guidelines) by the end of the fourth semester for evaluation. The student should produce a synopsis of his/her research work for the external examination and make a power point presentation of the same.

VIVA

There will be a comprehensive viva voce examination at the end of the fourth semester based on the theories in the field of sports biomechanics and the area of research conducted by the student be evaluated by the committee.

The split of ESE mark as follows 25 marks for Viva-Voce and 50 marks for Dissertation Evaluation.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Handle the practical problems to enhance the sports performance
CO2	Collect literature related to their research problem
CO3	Knows the methods to collect data
CO4	Knows the suitable statistics and able interpret the study result
CO5	Identifies the reason for modification and concludes

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Elective – 6 (Discipline Centric)
(Select any *one*)

Semester	23MSBE404: Applied Performance Analysis in Sports	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
IV		2	1		3	25	75	100

Learning Objective (LO):

LO1	This provides strong practical competencies in numerous performance analysis systems, specifically, those designed for match, motion, and technique analysis
LO2	This also provide a practical platform to assess Game tactics; offensive and defensive game-play; video data capture; video analysis coding development; coach and player feedback systems

Unit 1
System of Measurement in time-motion analysis - A case study of Soccer, Manual Notation system, Computerised generic system, Human operated / video-based semi-automatic player tracking systems, Global positioning systems, Automatic player tracking systems, sensor technology companies, Comparison studies; GPS systems – GPS, Inside GPS unit, Accelerometer, GPS validity and reliability - a collection of independent research findings, GPS application in rugby.

Unit 2
Probability analysis of noted events in sports contests: Skill and Chance – Skill & Chance, Probability: Stationarity and independence, Taking a random walk in field of probabilities, Investigating sports contests using probability analysis, Football: Identifying optimised game strategies for the penalty shoot-out, Football: the negative binomial distribution of passing sequences and the shot-to-goal ratio, on the requirement for invariant data for probability analysis of sports behaviour.

Unit 3
Dynamic systems and perturbations – Dynamic systems, features of dynamic systems, Inter-personal coordination, perturbations; Momentum and 'Hot hands' – The 'Hot hand' myth, momentum through notational analysis studies.

Unit 4
Performance profiling – Processes in creating performance profiles, profiling in canoeing – a practical example; Rule changes in sport and the role of notation – the role of notational analysis in tracking the effect of rule changes, Rules, and cheating.

Unit 5
Notational analysis of coaching behaviour – Introduction of notational analysis of coaching behaviour, Evolution of the analysis of coaching behaviour, purpose and examples of published work; Performance analysis in the media – Classifying games, invasion games, Net and wall games, striking and fielding games.

Text Books

1. McGarry, T; O'Donoghue, P & Sampaio, J. (2013), *Routledge Handbook of Sports Performance Analysis* , Routledge, UK.
2. O'Donoghue, P. (2014) *An Introduction to Performance Analysis of Sport* , Routledge, UK.
3. Hughes, M. (2008) *The Essentials of Performance Analysis: An Introduction* , Routledge, UK.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Demonstrate an understanding of the process of video notational analysis.
CO2	Identify the various video feedback methods and distinguish the most appropriate method in a variety of contexts.
CO3	Analyse various team sports technical/tactical skill contexts and provide appropriate feedback to athletes
CO4	Integrate all relevant skills and knowledge already acquired with all new skills and dispositions acquired in this subject area
CO5	Demonstrate an appreciation of the need for confidentiality with regard to player performance score during the process of team sports technical performance analysis.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

Semester	23MSBE405: Methods in Neuromechanics	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
IV		2	1		3	25	75	100

Learning Objective (LO):

LO1	To study about electrical stimulation (muscular and neural stimulation)
LO2	To study about mechanical properties of the musculoskeletal system, muscle stiffness, spinal reflexes, cortical reflexes, motor learning, kinematic and kinetic analysis
LO3	To study about neural control of muscle force during fatigue
LO4	To study about biomechanical movement synergies

Unit 1 – Biomechanics as an Interdisciplinary

Introduction, Measurement, Description, Analysis, and Assessment, Biomechanics and its Relationship with Physiology and Anatomy; Signal Processing – Introduction, Auto- and Cross-Correlation Analyses, Frequency Analysis, Ensemble Averaging of Repetitive Waveforms

Unit 2 – Kinematics

Kinematics, Kinematic Conventions, Direct Measurement Techniques, Imaging Measurement Techniques, Processing of Raw, Kinematic Data, Calculation of Other Kinematic Variables, Problems Based on Kinematic Data; Anthropometry, Scope of Anthropometry in Movement Biomechanics, Kinetics, Forces and Moments of Force.

Unit 3 – Mechanical Work

Mechanical Work, Energy, and Power, Calculation of Internal and External Work, Power Balances at Joints and Within Segments, Problems Based on Kinetic and Kinematic Data; Three-Dimensional Kinematics and Kinetics, Synthesis of Human Movement

Unit 4 – Muscle Mechanics

Force-Length Characteristics of Muscles, Force-Velocity Characteristics, Muscle Modeling; Kinesiological Electromyography – Introduction, Electrophysiology of Muscle Contraction, Recording of the Electromyogram, Processing of the Electromyogram, Relationship between Electromyogram and Biomechanical Variables

Unit 5 – Biomechanical Movement Synergies

The Support Moment Synergy, Medial/Lateral and Anterior/Posterior Balance in Standing, Dynamic Balance during Walking

Text Books

1. Winter DA, (2009), *Biomechanics and Motor Control of Human Movement*. John Wiley & Sons, Inc. USA.
2. Enoka RM, (2015), *Neuromechanics of Human Movement*, Human Kinetics, USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Understand the nature of signals
CO2	Explain kinematic measurement techniques
CO3	Synthesis human movement and performance
CO4	Assess electrophysiology of muscle and performance
CO5	Apply the obtained knowledge to creatively solve problems relating to sport, exercise, human movement and rehabilitation

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
	Weightage										**15**	**15**	**15**	**15**	**15**
	Weighted Percentage of Course Contribution to PSO's										**3.0**	**3.0**	**3.0**	**3.0**	**3.0**

SKILL ENHANCEMENT COURSE - III

Semester	23MSBS406: Biomechanics and Exercise Physiology of Running	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
IV		1		2	2	25	75	100

Learning Objective (LO):

LO1	This course provides knowledge of visceral organs involved during running and its acute and chronic adaptations to training.
LO2	This course provides the theoretical and practical basics in the running techniques analysis and the tools commonly used for studying biomechanics and physiology.

Unit 1 – Anatomy of the locomotor apparatus and basic principles of motion
Coordination and running mechanics, Structure and ways in which joints can move, generation of power at muscle level; structure and differentiation of muscles, joint moments, and passive tissue function; elasticity and reactive muscle action; Working of Biarticular joints; mechanism that regulates running.

Unit 2 – Generation of Energy and Running Technique
Energy, Capacity and power, cardiorespiratory system, maximal oxygen uptake; Running – High speed running, start and acceleration, constant low speed running.

Unit 3 – Training and adaptation
Principles of sports training, derived principles of training, adaptations, means and methods of training

Unit 4 – Running techniques in practice
Sensory system and coordination, condition and coordination, principles of overload, transfer of training, economy of training, Basic components of running, Constant-speed running, start and acceleration.

Unit 5 – Strength training for runners
Concepts, description and definition of different forms of power training, strength training and functional anatomy – biomechanical aspects, strength training, muscle structure, and function; Strength training (individual muscle groups), strength training for muscle chains working together, strength training for patterns of movement resembling running.

Textbook

1. Bosch F, Klomp R. (2005). Running Biomechanics and Exercise Physiology in Practice, Elsevier, Churchill Livingstone.
2. Ferber R, Macdonald S. (2014). Running Mechanics and Gait Analysis. Human kinetics, NJ,USA.

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Screen sedentary and athletes with simple laboratory tests for the functional evaluations.
CO2	Explain the anatomy of running
CO2	Gain better insight into running related biomechanical and physiological parameters influences running.
CO3	Sports Training Principles to enhance performance
CO4	Identifies the mistakes in running movement
CO5	Apply the obtained knowledge to design new training regime for athletes.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
	Weightage										15	15	15	15	15
	Weighted Percentage of Course Contribution to PSO's										3.0	3.0	3.0	3.0	3.0

Semester	23MSBS407: Introduction to 3D Modelling & Animation	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
IV		1		2	2	25	75	100

Learning Objective (LO):

LO1	To develop the skill & knowledge in 3D Modelling & Animation
LO2	Students will understand the knowhow and can function either as an entrepreneur or can take up jobs in the multimedia and animation industry, video studios, edit set-up and other sp. effects sectors.

Unit 1 - Computer-based Animation & Getting Started with Max

Definition of Computer-based Animation, Basic Types of Animation: Real Time ,Non-real-time, Definition of Modelling, Creation of 3D objects. Exploring the Max Interface, Controlling & Configuring the Viewports, Customizing the Max Interface & Setting Preferences, Working with Files, Importing & Exporting, Selecting Objects & Setting Object Properties, Duplicating Objects, Creating & Editing Standard Primitive & extended Primitives objects, Transforming objects, Pivoting, aligning etc.

Unit 2 - 2D Splines & Shapes& compound object
Understanding 2D Splines& shape, Extrude & Bevel 2D object to 3D, Understanding Loft & terrain, Modeling simple objects with splines, Understanding morph, scatter, conform, connect compound objects, blobmesh, Boolean ,Proboolean&procutter compound object.

Unit 3 - 3D Modelling and Keyframe Animation
Modeling with Polygons, using the graphite, working with XRefs, Building simple scenes, Building complex scenes with XRefs, using assets tracking, deforming surfaces & using the mesh modifiers, modeling with patches & NURBS; Creating Keyframes, Auto Keyframes, Move & Scale Keyframe on the timeline, Animating with constraints & simple controllers, animation Modifiers & complex controllers, function curves in the track view, motion mixer etc.

Unit 4 - Simulation & Effects and Lighting& Camera
Bind to Space Warp object, Gravity, wind, displace force object, deflectors, FFD space warp, wave, ripple, bomb, Creating particle system through parray, understanding particle flow user interface, how to particle flow works, hair & fur modifier, cloth & garment maker modifiers etc.; Configuring & Aiming Cameras, camera motion blur, camera depth of field, camera tracking, using basic lights & lighting Techniques, working with advanced lighting, Light Tracing, Radiosity, video post, mental ray lighting etc.

Unit 5 - Texturing with Max and Rendering with V-Ray
Using the material editor & the material explorer, creating & applying standard materials, adding material details with maps, creating compound materials & material modifiers, unwrapping UVs & mapping texture, using atmospheric & render effects etc; V-ray light setup, V-ray rendering settings, HDRI Illumination, Fine-tuning shadows, Final render setting etc.

Textbooks

1. Introduction to Multimedia and Its Applications (English, Paperback, Jain V. K.) Khanna Publishers
2. Master Adobe Photoshop, Illustrator, Premiere and After Effects by Wiley-dreamtech India Pvt. Ltd.
3. Adobe InDesign CC Classroom in a Book – Pearson

Course Outcomes (CO):

At the end of the course, the student will be able to

CO1	Define Computer-based Animation & Getting Started with Max
CO2	2D Splines, Shapes & compound object and 3D Modeling
CO2	Keyframe Animation and Simulation & Effects
CO3	Lighting & Camera
CO4	Texturing with Max
CO5	Rendering with V-Ray

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs) in the 3 – point scale [Strong – 3; Medium – 2; Low – 1].

	CO-PO Mapping (Course Articulation Matrix										Level of Correlation between PSO's & CO's				
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	2	2	2	2	3	2	3	2	2	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
	Weightage										15	15	15	15	15
	Weighted Percentage of Course Contribution to PSO's										3.0	3.0	3.0	3.0	3.0

Semester	23MSBX408: Extension Activity	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
IV					1	25	75	100

Extension Activity: The basic objective of extension activity is to create social awareness and knowledge of social realities to have concern for the welfare of the community and engage in creative and constructive societal development.

a. It is mandatory for every student to participate in extension activity.
b. All the students should enroll under NSS/NCC/CYRC/RRC/Physical Education or any other service organization in the university.
c. Student should put a minimum attendance of 40 hours in a year duly certified by the Programme Co-Ordinator.
d. Extension activity shall be conducted outside the class hours.
e. Extension activity is categorized as non-core course.

PHYSICAL EDUCATION

A. GUIDELINES

Regular Activities (120 Hours/Year - after working hours of the College) (in Total 240 Hours) The Physical Education curriculum will develop students' knowledge and skills in physical activities. This base of knowledge and skills in Physical Education is a core component of the wholesome development of an individual. It helps to create a fit citizen of our nation. Regular Activities will be prescribed by the Physical Director / Faculty i/c of the colleges / University as per the local needs of the institutions.

B. SCHEME OF EVALUATION

<table>
<tr><th rowspan="2">Nature of Activity</th><th rowspan="2">Evaluation Criteria</th><th rowspan="2">Level of Performance</th><th colspan="3">Mark for each category</th></tr>
<tr><th>Scoring Scheme</th><th>Maximum</th><th>Total (Maximum)</th></tr>
<tr><td rowspan="6">Regular Activities</td><td rowspan="3">Attendance</td><td>Up to 50%</td><td>10</td><td rowspan="3">30</td><td rowspan="6">70</td></tr>
<tr><td>51 to 75%</td><td>20</td></tr>
<tr><td>Above 75%</td><td>30</td></tr>
<tr><td>Fitness Progression</td><td>Flexibility, Strength and Endurance</td><td>From Semester I to IV</td><td>15</td></tr>
<tr><td rowspan="2">Participation</td><td colspan="2">Regular physical activities, games/sports & Intramural sports, health awareness activities, conference/seminar etc.</td><td rowspan="2">25</td></tr>
<tr><td colspan="2">Involvement in organising sports activities / tournaments / competitions</td></tr>
<tr><td rowspan="3">Special Camp</td><td colspan="3">Intramural Sports</td><td>10</td><td rowspan="3">30</td></tr>
<tr><td colspan="3">Intercollegiate / District Level</td><td>20</td></tr>
<tr><td colspan="3">Inter-University / State Level & Above</td><td>30</td></tr>
<tr><td colspan="4">Total</td><td>100</td></tr>
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