ANNAMALAI UNIVERSITY
Chidambaram, Tamilnadu

सत्यमेव जयते
MINISTRY OF YOUTH AFFAIRS & SPORTS
Government of India

MYAS - AU Department of Sports Sciences

SYLLABUS

for

M.Sc. (SPORTS BIOMECHANICS)

(Under Choice Based Credit System)

Session: 2019-20

ANNAMALAI UNIVERSITY
Chidambaram, Tamilnadu - 608002

Approved by the

MINISTRY OF YOUTH AFFAIRS AND SPORTS
Government of India

M.Sc. (SPORTS BIOMECHANICS)

REGULATIONS AND SYLLABUS

(For students admitted from academic year 2019-20 onwards)

MISSION

This programme is blended with both Sports Biomechanics and Performance Analysis. Both areas experiencing massive growth, virtually every professional club and elite athlete employ or work with sports biomechanist and performance analysts who provide them with objective data to ultimately improve sporting performance. The integration of both sports biomechanics and performance analysis module which facilitate our students to acquire very great skill or proficiency. Biomechanics is the integration of anatomical and mechanical aspects of human motion and in-depth study in functional anatomy and the mechanics of human movement. Students receive in-depth study in functional anatomy and the mechanics of human movement. Movement analysis is related to investigation of injuries (cause and prevention) or performance. Movement analysis utilizes instrumentation including high speed cameras, force measurement, electromyography and computer software to analyze human movement. This is often related to technique analysis and/or the design and development of equipment. Similarly, performance analysis provides expertise, technology integration solutions and performance analysis services to sport organizations, athletes, and coaches. The goal of the performance analysis is to help improve athlete techniques/skills and team tactics/strategies through the use of state-of-the-art video and other measurement technologies. This programme provides sports skill analysis, performance analysis services, education/training opportunities and research/development collaborations with sports teams to help in their quest of optimizing athlete performances. This programme offers platform for students to masterpiece their skill.

AIM

The aim of M.Sc. programme is to provide students with strong skills in the areas of Sports Biomechanics and Performance Analysis. The programme helps students become creative problem solvers with hands-on technical, research, oral, and written communication. This programme prepares our graduates at the forefront of new developments and helps in finding solution to the current problems faced by athletes and coaches.

OBJECTIVES

The M.Sc. Sports Biomechanics course is designed to provide an opportunity to students to apply theory to practice, which creates a highly valuable learning experience with clear vocational and professional significance. The content on M.Sc. Sports Biomechanics has been carefully designed to provide quality assured professional training to meet the needs of the athletes and to foster life-long learning in participants.

This programme is designed to:

- Develop knowledge and understanding of the principles and applications of sport biomechanics and performance analysis and their application to vocational/professional practice.
- Provide an opportunity to critically assess a broad range of theories, methodologies and research findings in sport biomechanics and performance analysis.
- Develop a critical understanding of how to apply theories, strategies and methodologies in appropriate ways.

- Enable the student to develop empirical rigour in identifying solutions to complex problems.
- Develop the appreciation of inter-related scientific concepts that promote understanding of problems and issues in the study of sport biomechanics and performance analysis.
- Provide a forum for the development of research skills and professional competencies in the field of sport biomechanics and performance analysis.

DEFINITION OF KEY WORDS

- **Programme:** An educational program leading to the award of a Degree, diploma or certificate.

- **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.

- **Semester:** Each semester consists of 15-18 weeks of academic work equivalent to 90 days of actual teaching days. The odd semester may be scheduled from July to December and even Semester from January to June.

- **CBCS (Choice Based Credit System):** It provides choice for students to select from the prescribed courses.

- **Course:** It is usually referred to as “Papers”. All courses need not carry the same weight. A course may comprise lectures/tutorials/laboratory, work/field, work/outreach activities/project work/vocational training/viva/seminars etc or a combination of some of these.

- **Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching or two hours of practical work.

- **Core course:** Are course that are basic to the subject of the degree. This is a course which is to be compulsorily studied by a student as a core requirement to the completion of the program.

- **Elective Courses:** This is a course that is supportive to the discipline of study, provides an expanded scope, enables exposure to some other domains or nurtures proficiency/skills. Elective papers can be of two types: Discipline Specific Elective (DSE) and Generic Elective (GE). Core / DS Electives will not be offered as Generic Electives. Elective papers can be taken from MOOC courses and credit transfer should be allowed.

- Each of the Core courses and Discipline Specific Elective (DSE) shall be of 4 credits. Credits under DSE may vary (16/12/8) depending upon the number of DSE courses offered across the semesters.

- **Department Elective (DE):** These courses are inter disciplinary in nature and considered similar to core course. And, the students have to choose one course from the option provided for them.

- **Inter Department Elective (IDE):** These courses add generic proficiency to the students. Students have to choose elective courses in consultation with the head of the department from the IDE courses offered by other Division of study in Sports Science or from other Departments in university.

COURSE STRUCTURE

This **M.Sc. Sports Biomechanics** is a programme consists of core courses, soft core courses, practical courses, internship and project work. The entire programme carries credit system. The number and distribution of credits for the programme will be decided by the respective faculties.

A programme is divided into two Semesters, Odd Semester and Even Semester. The normal Semester periods are:

Odd Semester: July to November (90 Working days)
Even Semester: December to April (90 Working days)

CREDITS

The term credit is used to describe the quantum of syllabus for various courses in terms and hours of study. It indicates differential weight age given according to the contents and duration of the courses in the curriculum design. The minimum credit requirement for a two years Master's Programme shall be 90-120.

One credit of theory equals one lecture hour and
One credit of practical equals two laboratory hours.

COURSES

Each Programme may consist of Lectures / Tutorials / Laboratory Work / Seminar / Project Work / Practical Training Report / Viva-Voce etc. Normally, in each of the programmes, credits will be assigned on the basis of the Lectures/Tutorials/Laboratory Work and other form of learning in 18 week schedule.

ELIGIBILITY FOR ADMISSION

A candidate who has passed Bachelor's Degree in Sports Sciences / Physical Education and 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.

Note: Proficiency in Sports is desirable.

GRADING SYSTEM

The term grading system indicates a 10 point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class.

DURATION

The duration for completion of two Years Master's programme in any subject is four Semesters, but in any case not more than five years from the year of admission.

ATTENDANCE

Every teaching faculty handling a course shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course.

The instructor of the course must intimate the Head of the Department at least Seven Calendar Days before the last instruction day in the semester about the particulars of all students who have secured an attendance of less than 80%.

A candidate who has attendance less than 80% shall not be permitted to sit for the end–semester examination in the course in which the shortage exists.

However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 80% attendance for valid reasons on payment of a condonation fee and such exemptions should not under any circumstances be granted for attendance below 70%.

EXAMINATION

There will be two sessional assessment tests and one End–Semester examination during each semester.

Sessional Test–I will be conducted after 35 working days and Sessional Test–II will be conducted after 70 working days.

Sessional Test–I will be a combination of a variety of tools such as class test, assignment and paper presentation that would be suitable to the course. This requires an element of openness. The students are to be informed in advance about the nature of assessment and the procedures. However, the tests are compulsory. Test–I may be for one hour duration. The pattern of question paper will be decided by the respective faculty. Sessional Test–I will carry 12.5% of marks of the entire course.

Sessional Test–II will be held after 70 working days for the syllabi covered between Seventh and Eleventh weeks.

Sessional Test–II will be conducted with a variety of assessment tools. It will also have an element of openness. The students are to be informed in advance about the nature of assessment and the procedures. However, the tests are compulsory. Test–II may be for two hours duration. The pattern of question paper will be decided by the respective Faculty. Sessional Test–II carries 12.5% of marks of the entire course.

There will be one End–Semester Examination of 3 Hours' duration in each course. The end semester examination will cover all the syllabus of the course for 75% of marks.

Each course shall carry a maximum of 100 marks for the purpose of grading. The distribution of marks shall be as follows.

Theory Marks			**Practical Marks**		
Internal	**External**	**Maximum**	**Internal**	**External**	**Maximum**
25	75	100	40	60	100

INTERNSHIP AND FIELD VISIT

The Internship / Practical Training shall carry 100 marks and shall be evaluated through internal assessment only. At the end of Internship / Practical training / Summer Project, the candidate shall submit a certificate from the organization where he /she has undergone training and a brief report. The evaluation will be made based on this report and a Viva-Voce Examination, conducted internally by a three member Departmental Committee constituted by the Head of the Department. Certificates (issued by the training centre or Organization) submitted by the candidate shall be attached to the mark list sent by the Head of the Department.

Field visit carry 100 marks and shall be evaluated through internal assessment only. At the end of field visit students has to submit the field visit report. Similarly, like internship evaluation will be made based on this report and a Viva-Voce Examination, conducted internally by a three member Departmental Committee constituted by the Head of the Department. Certificates (issued by the training centre or Organization) submitted by the candidate shall be attached to the mark list sent by the Head of the Department.

EVALUATION

Evaluation will be done on a continuous basis. Evaluation may be by Objective Type Questions, Quiz, Short Answers, Essays or a combination of these, but at the end semester it has to be a written examination.

The performance of students in each course is evaluated in terms of percentage of marks (PM) with a provision for conversion to Grade Point (GP). The sum total performance in each semester will be rated by GPA while the continuous performance from the 2nd Semester onwards will be marked by (OGPA).

MARKS AND GRADING

A student cannot repeat the Sessional Assessment Test–I and Sessional Test– II. However, if for any compulsive reason the student could not attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

A minimum of 50% marks in each course is prescribed for a pass. A student has to secure 50% minimum in the End Semester Examination.

If a candidate who has not secured a minimum of 50% of marks in a course shall be deemed to have failed in that course.

The student can repeat the End Semester Examination when it is offered next in the subsequent Odd/ Even semesters till the regulations are in force. However, a candidate cannot move to the next semester if he/she has more than six papers as arrears at any point of time.

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

GRADING

A ten point rating is used for the evaluation of the performance of the student to provide a letter grade for each course and overall grade for the Master's Programme. The letter grade assigned is given below:

Marks	Grade Point	Letter Grade	Class
90+	10	S	Exemplary
85-89	9.0	D	Distinction
80-84	8.5	D	Distinction
75-79	8.0	D	Distinction
70-74	7.5	A	First class
65-69	7.0	A	First class
60-64	6.5	A	First class
55-59	6.0	B	Second class
50-54	5.5	C	Second class
49 or less	-	F	Fail

The successful candidates are classified as follows:

I – Class 60% marks and above in over all percentage of marks (OPM).

II – Class 50–59% marks in over all percentage of marks.

Candidates who obtain 75% and above but below 91% of marks (OPM) shall be deemed to have passed the examination in First Class (Distinction) provided he/she passes all the course prescribed for the programme at the first appearance.

Candidates who obtain 90% and above (OPM) shall be deemed to have passed the examination in First Class (Exemplary) provided he/she passes the entire course prescribed for the programme at the first appearance.

For the Internal Assessment Evaluation the break up marks shall be as follows.

Test	10 marks
Assignment	05 marks
Case Study / Seminar / Short Answers etc.	05 marks
Attendance	05 marks
Total	25 Marks

Marks for Attendance Percentage

90% and above	5 Marks
80 – 89%	4 Marks
70 – 79%	3 Marks

COURSE–WISE LETTER GRADE

The percentage of marks obtained by a candidate in a course will be indicated in a letter grade. A student is considered to have completed a course successfully and earned the credits if he/she secures over all grades other than F. A letter grade F in any course implies a failure in that course. A course successfully completed cannot be repeated for the purpose of improving the Grade point.

The F 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 candidates has appeared for clearance of the arrears.

A student secures F grade in any course which is listed as course as to repeat it compulsorily when the course is offered next. If it is an elective course, a student has the option to repeat it when it is offered next or to choose a new elective if he / she is chosen in the place of failed elective / failed optional will be indicated as dropped in the subsequent grade card.

If a student secures F Grade in the Project Work/ Field Work/Practical Work/ Dissertation, either he/she shall improve it and resubmit it if it involves only rewriting incorporating the clarification of the evaluators of he/she can re–register and carry out the same in the subsequent semesters for evaluation.

WITHDRAWAL FROM THE COURSE BY THE STUDENT

Within two weeks from the date of commencement of the semester.

PROGRAM OUTCOMES (POs):

By the end of the program, the students will be able to

PO1	**Domain knowledge**: Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.
PO2	**Resource Utilisation.** Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.
PO3	**Analytical and Technical Skills:** Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
PO4	**Critical thinking and Problem solving:** Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.
PO5	**Project Management**: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.
PO6	**Individual and team work**: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
PO7	**Effective Communication**: Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
PO8	**Environment and Society**: Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO9	**Ethics**: Commitment to professional ethics and responsibilities.
PO10	**Life-long learning:** Ability to engage in life-long learning in the context of the rapid developments in the discipline.

PROGRAM SPECIFIC OUTCOMES (PSOs):

By the end of the program, the students will be able to

PSO1	Examine the essential health, safety and ethical aspects to be considered when undertaking applied sport and exercise biomechanics investigations.
PSO2	Manipulate, interpret and report conclusions related to a range of data and applied problems.
PSO3	Evaluate appropriate laboratory equipment to enable a sport and exercise biomechanics investigation to be undertaken.
PSO4	Integrate advanced scientific and professional skills in the context of sport and exercise biomechanics.

MAPPING OF PROGRAMME SPECIFIC OUTCOMES WITH PROGRAMME OUTCOMES

By the end of the program, the students will be able to

Programme Specific Outcomes (PSOs)	**Programme Outcomes (POs)**									
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
PSO1	3			3	2		3	3	3	3
PSO2	3		3	3	3	3		3	3	3
PSO3	3	3	3	3	2	3	3		3	3
PSO4	3	3	2	3	3	3	3	3		3

ANNAMALAI UNIVERSITY

Department of Sports Sciences
M.Sc. Sports Biomechanics
Programme Code: SSPO21

Programme Structure
(For Students admitted from the academic year 2019-2020)

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
Semester-I							
19MSBC101	Core 1: Introduction to Sports Biomechanics	4		4	25	75	100
19MSBC102	Core 2: Functional Anatomy	4		4	25	75	100
19MSBC103	Core 3: Research Methodology and Applied Statistics	4		4	25	75	100
19MSBP104	Practical I (Mechanics)		4	2	40	60	100
19MSBP105	Practical II (Functional Anatomy)		4	2	40	60	100
19MSBP106	Practical III (Excel & SPSS)		6	3	40	60	100
19MSBP107	Practical IV (Exposure to concerned Sports)		10	5	100	-	100
	Elective 1: Interdepartmental Elective	3		3	25	75	100
				27			
Semester-II							
19MSBC 201	Core 4: Fundamentals of Sports Performance Analysis	4		4	25	75	100
19MSBC 202	Core 5: Instrument for recording and analyzing sports movements	4		4	25	75	100
19MSBC 203	Core 6: Kinanthropometry	4		4	25	75	100
19MSBP 204	Practical V (3D, EMG)		4	2	40	60	100
19MSBP 205	Practical VI (Force plate, Dynamometer)		4	2	40	60	100
19MSBP 206	Practical VII (Kinanthropometry)		4	2	40	60	100
19MSBP 207	Practical VIII (Exposure to concerned Sports)		10	5	40	60	100
	Elective 2: Interdepartmental Elective	3		3	25	75	100
	Elective 3: Department Elective	2	2	3	25	75	100
				29			

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. **Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.**
2. **Students may opt for any Value-added Courses listed in the University website.**

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
Semester-III							
19MSBC 301	Core 7: Applied Sports performance Analysis	4		4	25	75	100
19MSBC 302	Core 8: MATLAB	4		4	25	75	100
19MSBC 303	Core 9: Biomechanical Analysis of Human Movement	4		4	25	75	100
19MSBP 304	Practical IX: (Performance Analysis in Sports)		4	2	40	60	100
19MSBP 305	Practical X: (MATLAB)		4	2	40	60	100
19MSBP 306	Practical XI: (Kinetic & Kinematic analysis of human movement)		4	2	40	60	100
19MSBP 307	Practical XII: (Exposure to concerned Sports)		8	4	100	00	100
	Elective 4: Interdepartmental Elective	3		3	25	75	100
	Elective 5: Department Elective	2	2	3	25	75	100
				28			
Semester-IV							
19MSBC 401	Core 10: Biomechanical analysis of Sports Skills	4		4	25	75	100
19MSBC 402	Core 11: Clinical Biomechanics	4		4	25	75	100
19MSBC 403	Core 12: Application of biomechanics to physiological systems	4		4	25	75	100
19MSBD 404	Project (Dissertation)		10	5	25	50	100
	Viva-Voce				-	25	
19MSBV 405	Project Field Visit		2	1	100	-	100
19MSBP 406	Practical XIII: (Kinetic & Kinematic analysis of Sports Skills)		4	2	40	60	100
19MSBP 407	Practical XIV: (Performance analysis in Team Sports)		4	2	40	60	100
19MSBP 408	Practical XV: (Physiological measurements)		3	2	40	60	100
				24			
	Total Credits			**108**			
	Value Added Courses						

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. **Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.**
2. **Students may opt for any Value-added Courses listed in the University website.**

Elective Courses

Department Electives (DE)

Sl. No	Course Code	Course Title	Hours/ Week		C	Marks		
			L	P		CIA	ESE	Total
1	19MSBE 207. 1	Motor control in Sports	2	2	3	25	75	100
2	19MSBE 207. 2	Methods in Neuromechanics	2	2	3	25	75	100
3	19MSBE 308. 1	Biomechanics of Sports injuries	2	2	3	25	75	100
4	19MSBE 308. 2	Biomechanics of Asanas	2	2	3	25	75	100

Interdepartmental Electives (IDE)

S. No.	Course Code	Course Title	Department	Hours/ week		C	Marks		
				L	P		CIA	ESE	Total
1.	19 SOSE 115.1	Soft Skills	English	3	0	3	25	75	100
2.	19 MATE 215.1	Discrete Mathematics	Mathematics	3	0	3	25	75	100
3.	19 MATE 215.2	Numerical Methods		3	0	3	25	75	100
4.	19 MATE 315.1	Differential Equations		3	0	3	25	75	100
5.	19 STSE 215.1	Statistical Methods	Statistics	3	0	3	25	75	100
6.	19 STSE 215.2	Mathematical Statistics		3	0	3	25	75	100
7.	19 STSE 315.1	Bio-Statistics		3	0	3	25	75	100
8.	19 PHYE 215.1	Classical Mechanics and Special Theory of Relativity	Physics	3	0	3	25	75	100
9.	19 PHYE 215.2	Physics of the Earth		3	0	3	25	75	100
10.	19 PHYE 315.1	Bio-Medical Instrumentation		3	0	3	25	75	100
11.	19 PHYE 315.2	Energy Physics		3	0	3	25	75	100
12	19 CHEE 215.1	Applied Chemistry	Chemistry	3	0	3	25	75	100
13	19 CHEE 315.1	Basic Chemistry		3	0	3	25	75	100
14	19 CHEE 315.2	Instrumental Methods of Analysis		3	0	3	25	75	
15	19 BOTE 215.1	Plant Tissue Culture	Botany	3	0	3	25	75	100
16	19 BOTE 215.2	Plant Science – I		3	0	3	25	75	100
17	19 BOTE 315.1	Gardening and Horticulture		3	0	3	25	75	100
18	19 BOTE 315.2	Plant Science – II		3	0	3	25	75	100

19	19 ZOOE 215.1	Animal Culture Techniques	Zoology	3	0	3	25	75	100
20	19 ZOOE 315.1	Environmental Science		3	0	3	25	75	100
21	19 GEOE 215.1	Environmental Geosciences	Earth Sciences	3	0	3	25	75	100
22	19 GEOE 315.1	Applied Geophysics		3	0	3	25	75	100
23	19 MIBE 315.1	Microbiology	Microbiology	3	0	3	25	75	100
24.	19 CISE 215.1	R Programming	Computer & Information Science	3	0	3	25	75	100
25	19MSSE206	Fundamentals of Sports Sciences	Department of Sports Sciences / Division o Sports Training & Sports Nutrition	3	0	3	25	75	100
26	19MSSE307	Basics of Strength and Conditioning		3	0	3	25	75	100
27	19MSPE107	Sports Injury & Rehabilitation	Department of Sports Sciences / Sports Physiotherapy	3	0	3	25	75	100
28	19MEPE306	Exercise and Elderly Population		3	0	3	25	75	100

Electives Offered to Other Departments

Interdepartmental Electives (IDE)

S. No.	Course Code	Course Title	Department	Hours/ week		C	Marks		
				L	P		CIA	ESE	Total
1	19MSBX 205.1	Physics in Sports	Sports Sciences / Division of Sports Biomechanics	3	0	3	25	75	100

Value Added Course

S. No.	Course Code	Course Title	Department	Hours/ week		C	Marks		
				L	P		CIA	ESE	Total
1	-	-	-	-	-	-	-	-	-

Semester- I **19MSBC101: Introduction to Sports Biomechanics** **Credits: 4**
Hours : 4

Learning Objective (LO):

1. The main goal of this course is to learn mechanical concepts and principles that govern human movement.
2. To build skills in quantitative and qualitative analyses of sports and games.
3. 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, Relationsip 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.

Unit 6

Biomechanics of sports and games, Internal and external forces production during sports participation, Sports equipment – energy and performance, Biomechanical simulation models of sports activities.

Text Books

1. Bunn, John W. **Scientific Principles of Coaching**, Second Edition. (Englewood cliffs, New Jersey : Prentice Hall, Inc. 1972)
2. Hall, Susan J. **Basic Biomechanics**, Fourth Edition (Boston etc. : WCB/MC Graw-Hill Companies, 2004)
3. Hay, James G. **The Biomechanics of Sports Techniques**, Fourth Edition (Englewood cliffs, New Jersey; Prentice Hall, 1993
4. Hay, James G. and Raid J. Gavin, **Anatomy, Mechanics and Human motion**, Second Edition (Englewood cliffs, New Jersey: Prentice Hall, 1988).
5. Kreighbaum, Ellen and Barthels. **Biomechanics – A qualitative Approach for studying Human movement.** Third edition (New York : MC millan publishing company, 1990)
6. Mc. Ginnis, Peter M. **Biomechanics of Sport and Exercise**, Second Edition (Champaign : Human kinetics publishers, 2005)
7. Rai Ramesh, **Biomechanics – Mechanical Aspects of human motion** (Mohali Punjab : Agrim Publication, 2003)
8. Robertson, D. Gordon E. et. Al. **Research Methods in Biomechanics**. (Champaign etc : Human kinetics publishers, 2004).

COURSE OUTCOMES (COs)

By 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)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3		3	3								3		3
CO2	3		2	3			3	3	3	3		3		3
CO3	3	3	3	3			3	3	3	3	2	3		3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2		3	3	3	3	2	3	3	3	3

Semester- I **19MSBC102: Functional Anatomy** **Credits: 4**
Hours : 4

Learning Objective (LO):

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

Unit 1 – Shoulder Complex

Anatomical and Functional, Characteristics of the Joints of the Shoulder, Combined Movement Characteristics of the Shoulder Complex, Muscular Actions Strength of the Shoulder Muscles Conditioning, Injury Potential of the Shoulder Complex; The Elbow and Radioulnar Joints - Anatomical and Functional, Characteristics of the Joints of the Elbow, Muscular Actions, Strength of the Forearm Muscles Conditioning, Injury Potential of the Forearm

Unit 2 – Wrist and Fingers

Anatomical and Functional, Characteristics of the Joints of the Wrist and Hand, Combined Movements of the Wrist and Hand, Muscular Actions, Strength of the Hand and Fingers Conditioning, Injury Potential of the Hand and Fingers; Contribution of Upper Extremity Musculature to Sports Skills or Movements - Overhand Throwing, The Golf Swing; External Forces and Moments Acting at Joints in the Upper Extremity

Unit 3 – Pelvis & Hip Complex and Knee

Pelvic Girdle, Hip Joint, Combined Movements of the Pelvis and Thigh, Muscular Actions, Strength of the Hip Joint Muscles, Conditioning of the Hip Joint Muscles, Injury Potential of the Pelvic and Hip Complex; The Knee Joint - Tibiofemoral Joint, Patellofemoral Joint, Tibiofibular Joint, Movement Characteristics, Muscular Actions, Combined Movements of the Hip and Knee, Strength of the Knee Joint Muscles, Conditioning of the Knee Joint Muscles, Injury Potential of the Knee Joint

Unit 4 – The Ankle and Foot

Talocrural Joint, Subtalar Joint, Midtarsal Joint, Other Articulations of the Foot, Arches of the Foot, Movement Characteristics, Combined Movements of the Knee and Ankle/Subtalar, Alignment and Foot Function, Muscle Actions, Strength of the Ankle and Foot Muscles, Conditioning of the Foot and Ankle Muscles, Injury Potential of the Ankle and Foot; Contribution of Lower Extremity Musculature to Sports Skills or Movements - Stair Ascent and Descent, Locomotion, Cycling; Forces Acting on Joints in the Lower Extremity - Hip Joint, Knee Joint, Ankle and Foot

Unit 5 – The Vertebral Column

Motion Segment: Anterior Portion, Motion Segment: Posterior Portion, Structural and Movement Characteristics of Each Spinal Region, Movement Characteristics of the Total Spine, Combined Movements of the Pelvis and Trunk; Muscular Actions - Trunk Extension, Trunk Flexion, Trunk Lateral Flexion, Trunk Rotation; Strength of the Trunk Muscles Posture and Spinal Stabilization - Spinal Stabilization, Posture, Postural Deviations; Conditioning - Trunk Flexors, Trunk Extensors, Trunk Rotators and Lateral Flexors, Flexibility and the Trunk Muscles, Core Training; Injury Potential of the Trunk; Effects of Aging on the Trunk; Contribution of the Trunk Musculature to Sports Skills or Movements; Forces Acting at Joints in the Trunk

Unit 6

Neuromusculoskeletal modelling and simulation of tissue load in the lower extremities, upper extremities, Spine. Artificial neural network models of sports motions, Biomechanical modelling and simulation of foot and ankle.

Text Books

1. Joseph Hamill, Kathleen M. Knutzen, Timothy R. Derrick, (2015). Biomechanical Basis of Human Movement (4th edition); Lippincott Williams & Wilkins, Philadelphia, USA

COURSE OUTCOMES (COs)

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

CO1: Describe the skeletal and muscular anatomy of the body and appreciate the difference between roles of muscles.
CO2: Describe and illustrate the movements possible at selected joints of the skeletal system.
CO3: Demonstrate basic understanding of human movement biomechanics.
CO4: Understand the importance of strength and flexibility of the muscles to perform actions without injury

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3		3	3	3				3	3	2	3		3
CO2	3		2	3				3	3	3		3		3
CO3	3	3	3	3		3	3	3	2	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	2	3	3

Semester- I 19MSBC103: Research Methods and Applied Statistics in Sports Biomechanics Credits: 4 Hours : 4

Learning Objective (LO):

1. Study about the research processes.
2. To study about the literature search and presentation.
3. To study about the preparation of research proposal and dissertation.
4. To study about the various statistical techniques
5. 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.

Unit 6

Knowledge discovery and database development, Data acquisition, including devices for measuring performance data, Motion tracking and analysis systems, Modelling and simulation, Match analysis systems, e-learning and multimedia in sports education

Text Books

1. Best W. John, Research in Education (Prentice Hall of India Private Limited, New Delhi, 1981).
2. Bose N.M., Research Methodology (Sher Niwas Publication, Jaipur, India, 2005).
3. Malesh L.M., Methodology of Research in Physical Education & Sports, (Metropolitan, New Delhi, 1994).
4. Gay R.L., Airasian Peter, Educational Research, (Merill, Prentice Hall, 1996).
5. Thomas R. Jerry, Nelson. Taek, Research Method in Physical Activity (Human Kinetics, 2001).
6. Clark H. David, Clarke Harrison H, Research Process is Physical Education Recreation and Health (Prentice Hall Inc. Englewood Cliffs, New Jersey, 1970).
7. Fern F. Adward, Advanced focus group research, (Saye Publication, New Delhi, 2001).
8. Silverman David, Doing qualitative research, (Saye Publication, New Delhi, 2000).
9. Verma,J.P. and Ghufran,M.(2012).Statistics for Psychology: A comprehensive Text. Tata McGraw Hill Education, New Delhi.
10. Verma, J.P.(2011). Statistical Methods for Sports and Physical Education. Tata McGraw Hill Education, New Delhi.
11. Verma J.P.(2013). Data Analysis in Management with SPSS Software Springer.
12. Arun Arthur & Arwn. N. Elaine, “Statistics for Psychology”, Prentice Hall, Upper Saddle river INC,1999.
13. Write E. Susan, “Social Science Statistics”, Allyn and Bacon INC.

COURSE OUTCOMES (COs)

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

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

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3		3	3	3				3	3	3	2		3
CO2	3		2	3				3	3	3		3		3
CO3	3	3	3	3		3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	3	3	3
CO5	3		3	2				3	3	3		3		3

Semester- I **19MSBP104: Practical I** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. To gain depth of knowledge regarding the fundamental problems experienced on play field and to arrive solution.
2. To study the aspects related to the application side of the tests
3. To providing a hands-on learning experience such as in measuring the Range of Motion, locating centre of Gravity, etc.

(Any *One* Test)

1. Manual calculations of various kinetic and kinematic parameters – distance, displacement, speed, velocity, acceleration, momentum, force, mass, weight, resultant vector, pressure, work, power, energy etc.
2. Stick diagram (basic techniques; anatomical posture, walking, push up, sit ups etc.)
3. Goniometry – measurement of joint ROM / Elgon
4. Basic anthropometric measurements (stature, sitting height, different body segment length, weight, BMI and skin fold measurements)

COURSE OUTCOMES (COs)

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

CO1: Show knowledge of kinematics and Kinetic in static condition.
CO2: Provide a hands-on learning experience and understand the basic concepts and applications of mechanics on playfield.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	3	3	3	2	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3	3	3	3	3

Semester- I **19MSBP105: Practical II** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. To introduce the concept of movement in different planes.
2. To introduce the concept of kinematic and kinetic analysis.
3. To develop familiarity with the physical properties of components of articular systems.
4. To introduce the anatomical tissues that influence human movement and their specific function.
5. To develop an understanding of how forces act on the body.
6. To introduce skills in the measurement and analysis of kinematic and kinetic parameters.
7. To introduce practical skills in biomechanics and functional anatomy.

(Any *One* Test)

1. Muscular actions around shoulder, elbow, wrist and fingers for various sports movements
2. Movements that cause injury to shoulder, elbow, wrist and fingers muscles with respect to sports movement
3. Measuring hip range of motion, knee range of motion, ankle/foot range of motion with respect to different activity.
4. Muscular actions around hip and lower extremity for various sports movements
5. Movements that cause injury to hip and lower extremity muscles with respect to sports movement
6. Calculating foot arch and assessing variety of injury with respect to foot position and loading.
7. Vertebral column – measuring movements and injury related to sports movement
8. Calculating range of motion around hip
9. Trunk muscle identification
10. Actions of Muscles during movement

COURSE OUTCOMES (COs)

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

CO1: Describe different types of movement in different anatomical planes and range of articular systems within the human body.
CO2: Describe the structural and functional components of articular systems.
CO3: Show an understanding of proportionality, kinetic and kinematic analysis and determine mathematically linear components of movement.
CO4: Determine simple biomechanical parameters relating to human movement.
CO5: Demonstrate a range of competencies including general transferable skills and technical skills associated with functional anatomy and biomechanics in the laboratory setting.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3		3	2	3				3	3	3	3		3
CO2	3							3	3	3		3		3
CO3	3	3				3	3	3	2	3	3	3	3	3
CO4	3	3	3	3	2	3	3			3	3	3	3	3
CO5	3		3	3				3	3	3		2		3

Semester- I **19MSBP106: Practical III** **Credits: 3**
Hours : 6

Learning Objective (LO):

1. Recognize the importance of data collection and its role in determining scope of inference.
2. Demonstrate a solid understanding of interval estimation and hypothesis testing.
3. Choose and apply appropriate statistical methods for analyzing one or two variables.
4. Use technology to perform descriptive and inferential data analysis for one or two variables.
5. Interpret statistical results correctly, effectively, and in context.
6. Understand and critique data-based claims.
7. Appreciate the power of data.

(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 (COs)

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

CO1: Select from, use and interpret results of, descriptive statistical methods effectively.
CO2: Demonstrate and understanding of the central concepts of modern statistical theory and their probabilistic foundation.
CO3: Select from, use, and interpret results of, the principal methods of statistical inference and design
CO4: Communicate the results of statistical analyses accurately and effectively.
.**CO5:** Make appropriate use of statistical software

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3		3	3	3				3	3	3	2		3
CO2	3		3	3				3	3	3		3		3
CO3	3	3	3	3		3	3	3	2	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO5	3		3	3				3	3	3		2		3

Semester- I **19MSBP107: Practical IV** **Credits: 5**
Hours : 10

LEARNING OBJECTIVE (LO):

1. Students will understand the importance of sound health and fitness principles as they relate to better health**.**
2. Students will be exposed to a variety of activities to enhance their sports skills
3. Students will demonstrate proficiency through knowledge and acquired skills

COURSE OUTCOMES (COs)

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

CO1: Understand the physical and physiological modifications due to sports participation
CO2: Demonstrate basic skills in selected sports using a mature movement pattern.
CO3: Demonstrate knowledge of history, rules, safety, and performance techniques in selected sports

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO2	3		3	3				3	3	3		3		3
CO3	3	3	2	3		3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	3	3	3

Semester- II **19MSBC201: Fundamentals of Sports Performance Analysis** **Credits: 4** **Hours : 4**

Learning Objective (LO):

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

Unit 1 - Sports Performance Analysis

Application area of sports performance analysis, Purpose of performance analysis in sports, Need for sports performance analysis, use of sports performance analysis, where, when, and how is sports performance analysis done, Match analysis and work rate analysis.

Unit 2 – Quantitative and Qualitative Analysis

Quantitative and Qualitative Analysis, Qualitative data and analysis – Photographs, inner athletes, qualitative movement diagnosis. Technological aids in qualitative analysis, automatically gathered data. Quantitative analysis of qualitative data – traditional notational method, etc., events where decision are independent of the analyst

Unit 3 – Sports Performance Data

Sports performance data and information – reductive approach, data & information, performance indicators and action variables, key performance indicators. Qualities of performance indicators – validity, objective measurement process, known scale of measurement, means of interpretation, examples of poor and good performance indicators. Process determining performance indicators – statistical and non statistical method.

Unit 4 – Analysis System

Developing analysis systems – system life cycle, requirements analysis – types & view point oriented requirements elicitation, System design and implementation – system testing, operation and maintenance

Unit 5 – Notation System

Guidelines for manual notation systems – use manual notations, types of manual notations system. Example of Scatter diagram, examples of frequency table, examples of sequential system.

Unit 6

Performance analysis - coaches, athletes, sports organisations and academic researchers, Collecting and interpreting performance data will enable coaches to improve their training programmes, athletes to make better tactical decisions, sports organisations to manage teams more effectively, and researchers to develop a better understanding of sports performance.

Text Books

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

4. Martens R. (2012) Successful Coaching 4th Edition , Human Kinetics
5. Hughes M., and Franks IM. (2008) The Essentials of Performance Analysis , London: Routledge
6. Magill RA. (2011) Motor Learning: Concepts and Application , McGraw-Hill
7. Schmidt RA, Lee TD. (2014) Motor Learning and Performance: From Principles and to Applications 5th Edition , Champaign, IL: Human Kinetics

COURSE OUTCOMES (COs)

By 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

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3		3	3				3	3	3		2		3
CO2	3	3	3	2		3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	2	3	3	3	3	3

Semester- II **19MSBC202: Instrument for Recording and Analyzing Sports Movements** **Credits: 4 Hours : 4**

Learning Objective (LO):

1. To study about cinematography and video analysis of two and three dimension
2. To study about the force platform and application of force measurement in sports biomechanics
3. To study about EMG in detail
4. 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

Unit 6

Processing, analysing and presenting Video-derived data, Motion analysis using online system, Force and pressure measurement application in daily life and while taking part in sports, surface electromyography application in movement analysis, application of isokinetic dynamometry, Computer stimulation modelling in sports.

Text Books

1. Paul Grimshaw et al. **Sports & Exercise Biomechanics,** Taylor & Francis Group, (2007).
2. Susan J. Hall, **Basic Biomechanics**, McGraw Hill Education, 2004.
3. Peter McGinnis **Biomechanics of Sport and Exercise**, Human Kinetics, 2005.
4. Kathryn Lutgens et al. **Kinesiology (Scientific Basis of Human Motion)**, Brown and Bench mark, 1992.
5. Roger Bartlett, **Introduction to Sports Biomechanics Analyzing Human Movement Patterns**, Routledge, 2007.
6. Knudson, Duane V**. Fundamentals of biomechanics**, Springer, 2007

COURSE OUTCOMES (COs)

By 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)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3		3	3	3	3	3	3	3	3	3
CO2	3		3	3				3	3	2		3		3
CO3	3	3	3	3		3	2	3	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	2	3
CO5	3	3	3	3		3	3	3	2	3	3	3	3	3

Semester- II **19MSBC203: Kinanthropometry** **Credits: 4**
Hours : 4

Learning Objective (LO):

1. To provide the knowledge of various methods of measuring body composition in humans.
2. 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

Unit 6

Sports biomechanist apply in assessing athletes Physique, Body Composition, Growth and development, Talent identification, Morphological optimization, Proportionality, body shape and performance, Evaluation of human body size, Ergonomical application -

Text Books

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

COURSE OUTCOMES (COs)

By 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, physique and somatotype

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO2	3	3	3	3		3	3	3	2	3	3	3	3	3
CO3	3	3	3	3		3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3

Semester- II **19MSBP204: Practical V** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. To introduce the underlying concepts of 3D analysis of linear and angular movement.
2. To examine motion analysis of sports skills.
3. Examine the electrical activity produced by skeletal muscle using EMG – Kinetic data.
4. To providing a hands-on learning experience with high speed cameras and EMG.

(Any *One* Test)

1. 3D Analysis of Sports Skills
2. EMG data obtained during a exercise

COURSE OUTCOMES (COs)

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

CO1: Show knowledge of kinematics and Kinetic in static conditions.
CO2: Provide a hands-on learning experience and understand the basic concepts and applications of mechanics and electrical activity of skeletal muscle on playfield.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	3	3	3	3	3	3

Semester- II **19MSBP205: Practical VI** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. To examine ground reaction force produced during walking, running and jumping.
2. Measuring strength and weakness of muscular strength using Dynamometer in athletes

(Any *One* Test)

1. Force Plate
2. Dynamometer

COURSE OUTCOMES (COs)

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

CO1: Determine ground reaction force and relating to human movement.
CO5: Measures the specific muscle strength of Athletes

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	2	3	3			3	3	3	3	3

Semester- II **19MSBP206: Practical VII** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. To provide the knowledge of various measurements to estimate physique and body composition,
2. To provide clear information about the length, width and girth measurements of bone and muscles helps to fix markers for motion analysis.

(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 (COs)

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

CO1: Safely and effectively use instrumentation and equipment to assess and record human anthropometry, physique and somatotype
CO2: Determine simple biomechanical parameters relating to human movement.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO3	3	3	3	3		3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3

Semester- II **19MSBP207: Practical VIII** **Credits: 5**
Hours : 10

LEARNING OBJECTIVE (LO):

1. Students will understand the importance of sound health and fitness principles as they relate to better health**.**
2. Students will be exposed to a variety of activities to enhance their sports skills
3. Students will demonstrate proficiency through knowledge and acquired skills

COURSE OUTCOMES (COs)

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

CO1: Understand the physical and physiological modifications due to sports participation
CO2: Demonstrate basic skills in selected sports using a mature movement pattern.
CO3: Demonstrate knowledge of history, rules, safety, and performance techniques in selected sports

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO2	3		3	3				3	3	3		3		3
CO3	3	3	3	3		3	3	3	2	3	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	3

Semester- III 19MSBC301: Applied Sports Performance Analysis Credits: 4
Hours : 4

Learning Objective (LO):

1. This provide strong practical competencies in numerous performance analysis systems, specifically, those designed for match, motion and technique analysis.
2. 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 – Manual

Examples of manual notations, Tennis – portioning tally areas, solution, exercise, analysis of data, temporal analysis. Soccer – problem, a sequential system, summary analysis form, exercise and solution.

Unit 2 – Computerized

Guidelines for computerized performance analysis system – General purpose video tagging packages. Analysis with video and without video

Unit 3 – Work – rate analysis

Example of computerized performance analysis system , Tennis – an initial solution, Soccer – possession example, work – rate analysis, two movement system.

Unit 4 – Reliability

Reliability testing – validity, objectivity, reliability. Source of inaccuracy, intra operator agreement, inter operator agreement, examples of reliability studies, relationship between validity, objectivity & reliability, computerized scoring in amateur boxing. Reliability statistics for categorical variables - categorical variables, percentage of error, Kappa, interpretation of Kappa.

Unit 5 – Time Motion Analysis

Time – motion analysis – Reliability of time motion analysis, assessing activity intensity (low, moderate and high), reliability assessment of numerical data – elapsed times & split times, percentage of error, relative & absolute reliability, systematic bias and random error

Unit 6

Understand performance profiling, ability to carry out performance profiling, ability analyse performance, knowledge to give feedback on sports performance.

Text Books

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

COURSE OUTCOMES (COs)

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

CO1: Demonstrate an understanding of the process of video notational analysis. - Identify the various video feedback methods and distinguish the most appropriate method in a variety of contexts. - Analyse various team sports technical/tactical skill contexts and provide appropriate feedback to athletes. - Examine theoretical concepts in an applied setting and report on the validity of each in situational contexts. - Integrate all relevant skills and knowledge already acquired with all new skills and dispositions acquired in this subject area.
CO2: Demonstrate an appreciation of the need for confidentiality with regard to player performance score during the process of team sports technical performance analysis. - Display an awareness of the value attached to effective research practice in sport and exercise sciences.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO2	3	3	3	3		3	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	2	3	3

Semester- II **19MSBC302: MATLAB** **Credits: 4**
Hours : 4

Learning Objective (LO):

1. To familiarize the student in introducing and exploring MATLAB & LABVIEW softwares
2. To enable the student on how to approach for solving sports biomechanics problems using simulation tools
3. To provide a foundation in use of this softwares for real time applications
4. 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

Unit 6

Matlab - image and video segmentation, representation, processing, corrections, inpainting, fusion, stitching, watermarking etc.

Text Books

1. Krister Ahlersten, An Introduction to Matlab
2. Brian Hahn and Dan Valentine, Essential MATLAB for Engineers and Scientists (Fifth Edition)
3. Stormy Attaway, Matlab: A Practical Introduction to Programming and Problem Solving 3rd Edition

COURSE OUTCOMES (COs)

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

CO1: To understand the use of Matlab in order to analyse signals in the investigation of human movement.

CO2: Enhance the ability to create a Matlab script that can read the data, improve data quality, visualize results and compute relevant signal characteristics of various signals relevant in movement science

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	3	2	3	3	3	3	3	3
CO2	3	3	3	3		3	3	3	3	3	3	2	3	3

Semester- III **19MSBC303: Biomechanical Analysis of Human Movement** **Credits: 4**
Hours : 4

Learning Objective (LO):

1. 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.

Unit 6

Understanding movement, movement screening, functional movement system and movement patterns, functional movement screening, movement pattern corrections, developing correcting strategies, and advance correcting strategies.

Text Books

1. Chapman, Arthur E (2008). Biomechanical analysis of fundamental human movements. Human Kinetics, Champaign, IL USA.

COURSE OUTCOMES (COs)

By 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

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO2	3	3	2	3		3	3	3	3	3	3	3	3	3
CO3	3	3	3	3		3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	3	2	3	3	3	3	3	3

Semester- III **19MSBP304: Practical IX** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. How Performance Analysis is utilized in a sporting context.

(Any *One* Test)

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

COURSE OUTCOMES (COs)

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

CO1: The application of Performance Analysis to the coaching process and the implications for training and competition.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	3	3	3	2	3	3	3	3

Semester- III **19MSBP305: Practical X** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. Exploring meaningful data from acquired raw data during biomechanical tests.

(Any *One* Test)

1. Filtering
2. Artifact

COURSE OUTCOMES (COs)

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

CO1: Learns to control various filters
CO2: Learns temporal processing and amplitude analysis

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	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

Semester- III **19MSBP306: Practical XI** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. To provide the knowledge of various sports movements assessed biomechanically.

(Any *One* Test)

1. Walking
2. Race Walking.
3. Running
4. Jumping
5. Throwing
6. Striking
7. Catching

COURSE OUTCOMES (COs)

By 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.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	2	3	3	3	3	3

Semester- III **19MSBP307: Practical XII** **Credits: 4**
Hours : 8

LEARNING OBJECTIVE (LO):

1. Students will understand the importance of sound health and fitness principles as they relate to better health**.**
2. Students will be exposed to a variety of activities to enhance their sports skills
3. Students will demonstrate proficiency through knowledge and acquired skills

COURSE OUTCOMES (COs)

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

CO1: Understand the physical and physiological modifications due to sports participation
CO2: Demonstrate basic skills in selected sports using a mature movement pattern.
CO3: Demonstrate knowledge of history, rules, safety, and performance techniques in selected sports

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3		3	2				3	3	3		3		3
CO2	3	3	3	3		3	3	3	3	2	3	3	3	3
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3

Semester- IV **19MSBC401: Biomechanical Analysis of Sports Skills** **Credits: 4**
Hours : 4

Learning Objective (LO):

1. Latest developments and scientific research on performance analysis in competitive sports.
2. Specific sports scenarios and athletes needs to enhance performance biomechanically.

Unit 1 – Biomechanical Concepts for Analysis

Concept and Application of Center of Gravity, Method To Locate Center of Gravity (Segmentation Method), Center of Mass and its Application, Conservation of Angular Momentum, Moment of Inertia and Its Application.

Unit 2 – Mechanical Analysis of Techniques of Track Events

Analysis of Track Events – Start, Standing start, Crouch start (Bunch, Medium, Elongated), Running, Hurdling – High Hurdles

Unit 3 – Mechanical Analysis of Techniques of Field Events

Analysis of Field Events – Jumps – Long Jumps, High Jumps, Throws – Shot put, Discus Throw, Javelin Throw.

Unit 4 – Team Game I

Basketball, Handball, Volleyball, Kabaddi, Badminton, Squash, and hockey - History of the game, legends, skills and technique, application of biomechanical principles, analysis of skills related each games and sports.

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Unit 5 – Team Game II

Football, cricket, boxing, fencing, gymnastics, golf, and cycling - History of the game, legends, skills and technique, application of biomechanical principles, analysis of skills related each games and sports.

Unit 6

Acquiring ability to develop movement skill, understanding biomotor abilities, patterns of motor system development, Efficiency in controlling forces: mechanical functions of movement.

Text Books

1. Hay, J. (1993). The Biomechanics of Sports Techniques, Benjamin Cummings.
3. McGinnis, Peter M. Biomechanics of Sport and Exercise, Human Kinetics, 2005.
4. Clarke, David H. Clarke, Harrison H. Research Process in Physical Education, New Jersey: Prentice Hall Inc. 1984.
5. Jerry R. Thomas, Jack K. Nelson and Stephen J. Silverman., Research Methods in Physical
1. Activity (5th Ed), New York: Human Kinetics. 2005.
6. Chris Gratton and Ian Jones., Research Methods for Sports Studies, London: Routledge, Taylor & Francis Group, 2004.
7. John W. Best and James V. Kahn., Research in Education (9th Ed.,), New Delhi:
2. Prentice Hall of India Pvt. 2006.
8. Robertson .E Gordon D et al. Research Methods in Biomechanics. New York: Human Kinetics. 2004.

COURSE OUTCOMES (COs)

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

CO1: Explain performance analysis in game, sports and its applications in game sports theory as well as game sports training.

CO2: Explain theoretical innovations in game, sports analysis including the mathematical background.

CO3: Apply technological innovations in game, sports analysis to questions of theoretical as well as practical performance analysis.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	3	3	3	2	3	3	3	3
CO2	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

Semester- IV **19MSBC402: Clinical Biomechanics** **Credits: 4**
Hours : 4

Learning Objective (LO):

1. To enable the student expertise of biomechanics staff and include: clinical gait analysis and virtual rehabilitation, muscle and tendon mechanics and biomechanical assessment and injury prevention

Unit 1 – Introduction of Clinical Biomechanics

Concept of Clinical Biomechanics, Chiropractic Technique, Motion Palpation, Principle of palpation technique

Unit 2 – Foot Mechanics in Locomotion

Footwear influence on walking and running, Plantar Fasciitis, Achilles Tendinopathy, Posterior Tibial Tendon Dysfunction, Lombard's Paradox

Unit 3 – Knee Clinical Mechanics

Knee Patellofemoral Syndrome, Knee Iliotibial Band Syndrome, Knee Ligament and Meniscus, Knee Biomechanical Alteration

Unit 4 – Clinical Mechanics of Hip and Spine

Hip Joint Dysfunction, Hip Impingement, Clinical Biomechanics of Spinal Manipulation, Biomechanics of Back Pain.

Unit 5 – Clinical Gait Analysis

Applications of gait analysis **-** Clinical gait assessment, Conditions benefiting from gait assessment Future developments, Gait assessment of neurological diseases - Gait assessment in Cerebral palsy, Gait assessment in Stroke, Gait assessment in Parkinson's disease, Gait assessment in Muscular dystrophy

Unit 6

An analysis of the mechanics of foot, knee, hip and spine, functional and clinical analysis foot, knee, hip and spine, clinical gait analysis.

Text Books

1. Clinical Biomechanics of the Spine, White and Panjabi 3rd Edition
2. Chiropractic Technique, Bergmann, Petterson and Lawrence
3. Clinical Biomechanics of Spinal Manipulation, Herzog
4. The Biomechanics of Back Pain, Adams, Bogduk, Burton and Nolan
5. Spinal Pelvic Stabilization, Hyland
6. Motion Palpation and Chiropractic Technique, Faye and Schaffer

7. Spinal Adjustive Technique, Esposito and Phillipso

COURSE OUTCOMES (COs)

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

CO1: Gain the knowledge of Muscle palpation for locating the Joint and Muscular Structure
CO2: Able to differentiate the Injuries along with their treatment
CO3: Describe the Injury due to the possible mechanical error and also able to recommend the exercise on the basis of mechanics
CO2: Critically analyse human movement to be able to identify normal and pathological gait function and the parameters integral to successful movement execution

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	3	3	2	3	3	3	3	3
CO2	3	3	2	3		3	3	3	3	3	3	3	3	3
CO3	3	3	3	3		3	3	3	3	3	2	3	3	3
CO4	3	3	3	3		3	2	3	3	3	3	3	3	3

Semester- IV **19MSBC403: Application of Biomechanics to Physiological Systems** **Credits: 4** **Hours : 4**

Learning Objective (LO):

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

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

Unit 6

Assessing physiological systems function and biomechanical application in cardiovascular, respiratory and thermal response the practical difficulties in measuring and interpreting require greater skill to perform.

Text Books

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

COURSE OUTCOMES (COs)

By 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: Analyze the forces of various biological systems during static and dynamic human activities; analyze the stresses and strains in biological tissues.

CO3: Understand the principles of mechanics that is used to analyze biological systems.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	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
CO3	3	3	3	3	3	2	3	3	3	3	3	3	3	3

Semester- IV **19MSBD404: Project (Dissertation)** **Credits: 5**
Hours : 10

Learning Objective (LO):

1. Investigating current research problem and finding solution

COURSE OUTCOMES (COs)

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

CO1: Handle the practical problems to enhance the sports performance.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3		3	3	3	3	3	3	3	3	3

Semester- IV **19MSBP405: Practical XIII** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. Kinetic and Kinematic analysis of Sports Skills

(Any *One* Skill)

1. Team game
2. Individual Sports

COURSE OUTCOMES (COs)

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

CO1: Learns to assess the sports skills
CO2: Learns to identify the mistakes and correct biomechanically

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	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

Semester- IV **19MSBP406: Practical XIV** **Credits: 2**
Hours : 4

Learning Objective (LO):

1. To provide the knowledge to assess various physiological systems.

(Any *One* Test)

1. Heart rate, blood pressure
2. Vo2 max
3. Lung volumes
4. Skin temperature, rectal temperature and oral temperature

COURSE OUTCOMES (COs)

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

CO1: Understand the biomechanical role on physiological variables
CO2: Learns to measure physiological variables

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	2	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	2	3	3	3

Semester- IV **19MSBV407: Project Field Visit** **Credits: 1**
Hours : 2

LEARNING OBJECTIVE (LO):

1. Students will Diagnose the cause for deterioration in the sports performance and make timely decision for referral to sports coaches and scientists

COURSE OUTCOMES (COs)

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

CO1: Demonstrate skills in monitoring of the elite athletes and oriented to provide remedies to overcome their weakness associated with their sports.

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3		3	3				3	2	3		3		3

Elective Courses

Department Electives (DE)

Semester- II **19MSBE207. 1: Motor Control in Sports** **Credits: 3**
Hours : 4

Learning Objective (LO):

1. This will examine the theoretical and applied concepts relating to performance and learning of perceptual-motor skills in everyday lifestyle, recreational and sport tasks.

Unit 1 – Basics of Motor Control

Concept of motor control, Theories of Motor Control, Concept of Motor Learning, Forms of Learning, Non Associative Learning, Associative Learning - Classical Conditioning, Operant Conditioning, Procedural and Declarative Learning

Unit 2 – Physiology of Motor Control

Propiroception and Motor Control- Muscle Spindle, Stretch Reflex Loop, Golgi tendon organ, Joint Receptors, Vision and Motor Control,

Unit 3 – Motor Action

Action System- Motor Cortex and its Function, Role of The Cerebellum and Basal Ganglia

Unit 4 – Posture and Balance Control

Defining the task and System of Postural Control, Motor Mechanism for Postural Control, Senses Contribution for postural Control, Adaption of Senses for Postural Control

Unit 5 – Motor control and performance

Classification of Motor Skill, Performance Characteristics of Complex Skills, Causes of Inefficient Movement, Efficiency of Muscle

Unit 6

Challenges in motor control and motor learning under fatigue conditions, movement disorders – implications for the understanding of motor control.

Text Books

1. Winter A. David 1979 : Biomechanics of Human Movement John Wiley and Sons, Inc USA
2. Cook A. Shumway, Woollacott Marjorie; Motor Control Theory and Practical Application Lippincott Williams & Wilkins, Baltimore USA
3. Schmidt RA , Motor Control and Learning 2nd Ed Champaign, IL: Human Kinetics , 1988
4. Perry J. Gait Analysis: Normal and Pathological Function. Thorofare, NJ:Slack Inc ., 1992

COURSE OUTCOMES (COs)

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

CO1: Differentiate various Motor Learning Process
CO2: Describe the Mechanism responsible for the movement

CO3: Develop an Understanding of how the body controls posture and the factors of inefficiency

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	3	2	3	3	3	3	3	3
CO2	3	3	3	2		3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	2	3	3	3

Semester- II **19MSBE207. 2: Methods in Neuromechanics** **Credits: 3**
Hours : 4

Learning Objective (LO):

1. To study about electrical stimulation (muscular and neural stimulation)
2. To study about mechanical properties of the musculoskeletal system, muscle stiffness, spinal reflexes, cortical reflexes, motor learning, kinematic and kinetic analysis
3. To study about neural control of muscle force during fatigue
4. 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

Unit 6

Adaptability of the motor system – Acute and Chronic adaptations.

Text Books

1. Winter, Biomechanics and Motor Control of Human Movemnt. Wiley.
2. Enoka, Neuromechanics of Human Movement, Human Kinetics.

COURSE OUTCOMES (COs)

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

CO1: Understand theories of motor control and neuromechanics, principles of motor learning and their practical implications, and how these relate to both the neuromuscular physiology and biomechanics

CO2: 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)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	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	2	3

Semester- III **19MSBE308. 1: Biomechanics of Sports Injuries** **Credits: 3**
Hours : 4

Learning Objective (LO):

1. Understand the injury to that occurs on bone, cartilage, muscle and ligament to movements.
2. Understand how specific sports surfaces behave
3. Understand the influence that sports surfaces have on injury
4. Understand the influence of footwear on injury in sport and exercise, with particular reference to impact absorption and rearfoot control appreciate the injury moderating role of other protective equipment for sport and exercise
5. Understand the effects of technique on the occurrence of musculoskeletal injury in a variety of sports and exercises

Unit 1 – Causes of injury and the properties of materials

Causes of injury, Biological and other materials, Response of a material to load, Stress and strain, Elastic modulus and related properties, Plasticity and strain energy, Toughness and crack prevention, Hardness, Creep, Fatigue failure, Non-homogeneity, anisotropy and viscoelasticity, Stress concentration, Bone, Structure and composition

Unit 2 – Bone, Ligament & Tendon

Bone - loading and biomechanical properties, Cartilage, Structure and composition, Biomechanical properties, Muscle properties and behaviour, Muscle elasticity and contractility, Maximum force and muscle activation, Mechanical stiffness, The stretch-shortening cycle, Ligament and tendon properties, Factors affecting properties of biological tissue, Immobilisation and disuse, Age and sex, Exercise and training, Warm-up

Unit 3 – Sports Equipments

The effects of sports equipment and technique on injury: Sports surfaces – Introduction, Characteristics of sports surfaces, Specific sports surfaces, Biomechanical assessment of surfaces, Injury aspects of sports surfaces.

Unit 4 – Footwear

Footwear - biomechanics and injury aspects – Introduction, Biomechanical requirements of a running shoe, The structure of a running shoe, Footwear and injury, Impact and the running shoe, Running shoes and rear foot control

Unit 5 – Other sports and exercise equipment and injury

The head and neck, The upper extremity, The lower extremity, Alpine skiing: release bindings. Musculoskeletal injury—technique aspects, Introduction, The head and trunk, The upper extremity, The lower extremity.

Unit 6

Calculating load and injury, sports equipment and technique on injury and prevention requires scientific approach.

Text Books

1. Bartlett, Roger. (1999). Sports biomechanics: Preventing injury and improving performance, Routledge Publications

COURSE OUTCOMES (COs)

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

CO1: Acquire knowledge to overcome and prevent different types of injury on various structures due to sports equipment and technique on injury

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	2	3	3	3	3	3	3	3

Semester- III **19MSBE308. 2: Biomechanics of Asanas** **Credits: 3**
Hours : 4

Learning Objective (LO):

1. Understand how biomechanics can be used in yoga perspective.
2. 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

Unit 6

Yoga and biomechanical application, role of muscle movement and injury prevention.

Text Books

1. Francoise et al. Yoga and Pilates for everyone, Joanna lawrenz, 2006

COURSE OUTCOMES (COs)

By 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

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		3	3	2	3	3	3	3	3	3

Electives Offered to Other Departments

Interdepartmental Electives (IDE)

Semester- II **19MSBX205. 1: Physics in Sports** **Credits: 3**
Hours : 3

Learning Objective (LO):

1. Understand the physics behind popular sports
2. Use physical principles to solve problems relating to the physics of sports
3. Use sport as a means of enhancing science classes

Unit 1

Speed, acceleration and Usain Bolt - Speed, average and instantaneous speed, velocity, difference between speed and velocity, acceleration., Usain bolt, Speed of animas, light, sound and long distance

Unit 2

Newton's laws of motion – application in football and other games, estimate the flight path of a football, the concept of momentum and basketball bounce, impulse and momentum, conservation of momentum

Unit 3

Pirouettes and rotational motion – angular speed, velocity, and acceleration, understanding rotator motion in discus, centripetal force and gymnastics, moment of inertia and angular momentum in gymnastics, conservation of angular momentum.

Unit 4

Projectiles in sports: projecting for vertical distance – understanding projections for vertical distance, projecting for horizontal distance - understanding projections for horizontal distance, projecting for accuracy - understanding projection for accuracy and speed.

Unit 5

Aerodynamic in sports - drag force, lift force, magnus effect, understanding aerodynamic lift force and the magnus effect in sports

Unit 6

Understanding application of physics in sports

Text Books

1. Ellen Kreighbaum and Katharine M. Barthels. (1985). Biomechanics: A Qualitative Approach for Studying Human Movement (Second Edition), Macmillan Publishing Company, New York, USA.

COURSE OUTCOMES (COs)

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

CO1: Learn how speed and acceleration relate to sprinting
CO2: Understand how Newton's laws of motion determine the path of a football
CO3: Applying the principles of rotational motion to gymnastics, figure skating and diving
CO4: Learn what the optimum launch angle are for long jump and other sports projectiles

CO5: Apply basic aerodynamic principles to the javelin, ski jumping and swimming
CO6: Estimate the effect of wind speed, altitude, temperature, and equipment on various sports

MAPPING WITH COURSE OUTCOMES (COs) and PROGRAMME SPECIFIC OUTCOMES (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3		3	3	3	3	3	3	3	3	3
CO2	3	3	3	3		3	2	3	3	3	3	3	3	3
CO3	3	3	3	2		3	3	3	3	2	3	3	3	3
CO4	3	3	3	3		3	3	2	3	3	3	3	3	3
CO5	3	3	3	3		3	3	3	3	3	3	2	3	3
CO6	3	3	3	3		3	3	3	3	3	3	3	2	3