ANNAMALAI UNIVERSITY

ANNAMALAINAGAR - 608002
(A State University Accredited with 'A' Grade by NAAC)

MYAS-AU DEPARTMENT OF SPORTS SCIENCES

DIVISION
of
SPORTS BIOMECHANICS

MASTER OF SCIENCE
IN
SPORTS BIOMECHANICS

REGULATIONS AND SYLLABUS

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

UNDER CHOICE BASED CREDIT SYSTEM

M.Sc. SPORTS BIOMECHANICS

REGULATIONS AND SYLLABUS

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

1. 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 and exercise biomechanics and their application to vocational/professional practice.
- Provide an opportunity to critically assess a broad range of theories, methodologies and research findings in sport and exercise biomechanics.
- 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 and exercise biomechanics.
- Provide a forum for the development of research skills and professional competencies in the field of sport and exercise biomechanics.

2. 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.

- **Discipline Specific Elective (DSE):** 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.

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

3. 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)

4. 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.

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

5. 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 a 18 week schedule.

6. Eligibility for Admission:

A candidate who has passed Bachelor's Degree in Sports Sciences / Physical Education and Sports / 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) orequivalent thereto in 10+2+3 or 10+2+4 pattern from a recognized university with a minimum of 50% marks in aggregate.

7. 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.

8. 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.

9. 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%.

10. 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 to 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

11. 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.

12. 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).

13. 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.

14. 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
80-85	8.5	D	Distinction
75-79	8.0	D	Distinction
72-74	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

15. 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.

16. Withdrawal from the course by the student:

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

M.Sc. Sports Biomechanics: Two-Year (4-Semester) CBCS Programme								
Programme Structure								
Semester – I								
Course Code	**Course Title**	**Course Type**	**No of Credit**	**No. of Credit Hours**			**Marks Split**	
				Theory	**Practical**	**Total**	**Int**	**Ext**
MSBC101	Research Methodology in Sports Biomechanics	Core	4	4	0	4	25	75
MSBC102	Foundations of human movement	Core	5	4	2	6	25	75
MSBC103	Fundamental Biomechanics	Core	4	3	2	6	25	75
MSBC104	Functional Anatomy	Core	4	3	2	6	25	75
MSBE105	Discipline Specific Elective Any *one* a. Foundation of Strength Training and Conditioning b. Biomechanics of Sports Injury	Elective	4	3	2	5	25	75
	Generic Elective	Elective	3	3	-	3	25	75
		Total	**24**	**20**	**08**	**28**	**150**	**450**

Note: Int: Internal; Ext: External

Note: Students has to select *Generic Elective* from other Divisions in Department of Sports Sciences or from other Departments in the University.

M.Sc. Sports Biomechanics: Two-Year (4-Semester) CBCS Programme								
Programme Structure								
Semester – II								
Course Code	**Course Title**	**Course Type**	**No of Credits**	**No. of Credit Hours**			**Marks Split**	
				Theory	**Practical**	**Total**	**Int**	**Ext**
MSBC201	Advanced Statistics and Scientific data processing	Core	4	4	0	4	25	75
MSBC202	Kinesiology	Core	4	4	0	4	25	75
MSBC203	Techniques for recording and analyzing sports movements	Core	4	4	0	4	25	75
MSBC204	Joint range of Motion and Muscle Length Testing	Core	3	3	0	3	25	75
MSBE205	*Generic Elective* Physics in Sports	Elective	3	3	0	3	25	75
	Value Added course	Elective						
MSBP206	Practical – I a. Force plate b. Dynamometer c. EMG	Practical	6	0	12	12	40	60
Total			**24**	**18**	**12**	**30**	**165**	**435**

Note: Int: Internal; Ext: External

Note: Students has to select *Generic Elective* from other Divisions in Department of Sports Sciences or from other Departments in the University (or) *Value Added Course* from other Faculty in the University

MSBG205: Generic Elective – Physics in Sports is not offered M.Sc Sports Biomechanics Students but it is offered for other Divisions in Department of Sports Sciences or from other Departments in University

M.Sc. Sports Biomechanics: Two-Year (4-Semester) CBCS Programme								
Programme Structure								
Semester – III								
Course Code	**Course Title**	**Course Type**	**No. of. Credits**	**No. of Credit Hours**			**Marks Split**	
				Theory	**Practical**	**Total**	**Int**	**Ext**
MSBC301	Dynamics of Gait	Core	4	4	-	4	25	75
MSBC302	MATLAB	Core	4	4	-	4	25	75
MSBC303	Kinanthropometry	Core	3	3	-	3	25	75
MSBC304	Strength and conditioning and application of biomechanics	Core	3	3	-	3	25	75
MSBE305	Discipline Specific Elective Any *one* a. Biomechanics of Skeletal System b. Methods in Neuro-mechanics	Elective	4	3	2	5	25	75
	Generic Elective	Elective	3	3	-	3	25	75
MSBP306	Practical – II a. Gait b. Strength and Conditioning analysis c. MATLAB	Practical	2	0	4	4	40	60
MSBI307	Internship	Internship	1	0	2	2	100	--
		Total	**24**	**22**	**08**	**28**	**290**	**510**

Note: Int: Internal; Ext: External

Note: Students has to select *Generic Elective* from other Divisions in Department of Sports Sciences or from other Departments in the University

M.Sc. Sports Biomechanics: Two-Year (4-Semester) CBCS Programme								
Programme Structure								
Semester – IV								
Course Code	**Course Title**	**Course Type**	**No. of Credits**	**No. of Credit Hours**			**Marks Split**	
				Theory	**Practical**	**Total**	**Int**	**Ext**
MSBC401	Biomechanical Analysis of Athletics and team games	Core	4	4	-	4	25	75
MSBC402	Application of Biomechanics to Physiological Systems	Core	4	4	-	4	25	75
MSBC403	Biomechanics of Asanas	Core	3	3	-	3	25	75
MSBD404	Project Work including Presentation, Comprehensive Viva (Related to their Specialization selected)	Core	4	0	8	8	25	75
	Value Added course	Elective						
MSBP405	Practical – III a. Biomechanical analysis of technique in track and Field and team games b. Biomechanical analysis of Asanas	Practical	3	0	6	6	40	60
MSBV406	Field Visit	Practical	1	0	2	2	100	-
		Total	**19**	**11**	**16**	**27**	**240**	**360**

Note: Int: Internal; Ext: External

Note: Students has to select *Generic Elective* from other Divisions in Department of Sports Sciences or from other Departments in the University (or) *Value Added Course* from other Faculty in the University

Semester	Credit	Internal (Marks)	External (Marks)	Total (Marks)
I	24	150	450	600
II	24	165	435	600
III	24	290	510	800
IV	19	240	360	600
Total	**91**	**845**	**1755**	**2600**

M.Sc. SPORTS BIOMECHANICS
(Semester I)

<table>
<tr><td colspan="2">Course Code: MSBC 101</td><td>Course Title: RESEARCH METHODOLOGY IN SPORTS BIOMECHANICS</td></tr>
<tr><td rowspan="2">Max Marks: 100</td><td>Semester I</td><td>Credits: 4</td></tr>
<tr><td>Internal : 25</td><td>External : 75</td></tr>
<tr><td>Learning Objectives</td><td colspan="2">1. Introduction to scientific method; introduce research designs which seek to describe variables, establish relationships between variables and/or differences between groups.
2. To study about the various types of research.
3. Evidence-based practice.
4. Ethical principles of human research
5. To study about the literature search and presentation.
6. To study about the preparation of research proposal and dissertation.
7. Academic writing and publishing</td></tr>
<tr><td>Learning Outcomes</td><td colspan="2">1. Understand advanced epidemiology
2. Understand details of different epidemiological study designs
3. Understand study planning and conduct
4. Understand the importance of ethical issues
5. Understand the responsibilities of research ethics committees
6. Apply Good Epidemiological Practice
7. Apply principles of ethics and international quality standards
8. Understand informed consent
9. Write a research grant proposal
10. Develop a study design (including literature review / analysis / ethics)
11. Understand study conduct
12. Apply study analysis
13. Understand bias and confounding</td></tr>
<tr><td>Suggested readings</td><td colspan="2">1. Hay, J. (1993). The Biomechanics of Sports Techniques, Benjamin Cummings.
2. McGinnis, Peter M. Biomechanics of Sport and Exercise, Human Kinetics, 2005.
3. Clarke, David H. Clarke, Harrison H. Research Process in Physical Education, New Jersey: Prentice Hall Inc. 1984.
4. Jerry R. Thomas, Jack K. Nelson and Stephen J. Silverman., Research Methods in Physical Activity (5th Ed), New York: Human Kinetics. 2005.
5. Chris Gratton and Ian Jones., Research Methods for Sports Studies, London: Routledge, Taylor & Francis Group, 2004.
6. John W. Best and James V. Kahn., Research in Education (9th Ed.,), New Delhi: Prentice Hall of India Pvt. 2006.
7. Robertson .E Gordon D et al. Research Methods in Biomechanics. New York: Human Kinetics. 2004.</td></tr>
<tr><td>Unit 1</td><td colspan="2">Meaning and Definition of Research, Nature and Characteristics of Research, Needs of research in physical education, Unscientific Versus Scientific Methods of Problem Solving, Classification of Research – Basic and Applied. Types of Research - Analytical, Descriptive, Experimental and Qualititative.</td></tr>
</table>

Unit 2	Identifying the Research Problem, Locating the Research Problem, Criteria adopted in Selecting the Research Problem. Meaning and Formulation of Research Hypothesis. Delimitations, Limitations, Needs of Significance of the Study. Need for Surveying Related Literature, Purpose for Surveying Related Literature, Kinds of Related Literature, Literature Sources – Primary and Secondary, Steps in Literature Search
Unit 3	Need and Importance of Formulating the Method, Describing Participants, Sampling techniques, Describing Instruments, Describing Procedures, Describing Design and Analysis. Ethical Issues in Research: Areas of Scientific Dishonesty, Ethical Issues regarding Copyright Responsibilities of Researcher, Working Ethics with Faculty, Protecting Human Participants. Historical Research: Meaning of Historical Research, Steps of Historical Research, Evaluation of Historical Data, Internal Criticism and External Criticism.
Unit 4	Philosophical Research**:** Meaning and Purposes of Philosophical Research, Analysis of Philosophical Research, Inductive Reasoning, Deductive Reasoning. Descriptive Research: Survey Studies, Tools of Survey Research, Questionnaire, Construction and Appearance, Interview: Preparation and Conducting, Steps in the survey research process. Other Descriptive Research: Developmental Research, Case Study, Observational Research. Experimental Research: Meaning of Experimental Research, Sources of Invalidity in Experimental Research, Threats to internal Validity, Threats to External Validity, Controlling threats to Internal and External Validity.
Unit 5	Types of Experimental Design: Pre-experimental Design, True-experimental Designs, Quasi-experimental Designs. Completing the Research Process, Research Proposal, Developing a Good Introduction, Describing the method, results and discussion. The Proposal Process (How to prepare the formal proposal?), Preparation and uses of tables and figures. Basic Writing Guidelines: Thesis and Dissertation Format, Limitations of Chapter Style, Structure of the Journal Format, Writing abstracts, Oral and poster presentation

Course Code: MSBC 102		**Course Title:** FOUNDATIONS OF HUMAN MOVEMENT
Max Marks: 100	Semester I	Credits: 5
	Internal : 25	External : 75
Learning Objectives	1. To study about mechanics, biomechanics and kinesiology 2. To study about Planes and axis. 3. To study about the skeletal consideration for movement. 4. To study about the muscular consideration for movement. 5. To study about role of muscle on movement 6. To study about neurological consideration for movement	
Learning Outcomes	1. Understand anatomical movements pertaining to mechanics 2. Understand details of bone structure, biomechanical characteristics of bone and joints 3. Understand the responsibilities of muscles for movement 4. Apply principles of force – velocity relationship in skeletal muscle for strengthening and injury prevention.	

	5. Understand the importance of nervous system on movement and its role on various types of exercise 6. Understand the use of EMG for movement
Suggested readings	Joseph Hamill, Kathleen M. Knutzen, Timothy R. Derrick, (2015). Biomechanical Basis of Human Movement (4th edition); Lippincott Williams & Wilkins, Philadelphia, USA
Unit 1	**Unit- I** Mechanics, Biomechanics, Kinesiology – Biomechanics versus kinesiology – Anatomy versus Functional Anatomy – Linear versus Angular Motion – Kinematic versus Kinetics- Static versus Dynamic – Anatomical Movements – Anatomical Terms – Planes and Axes.
Unit 2	Skeletal consideration for movement: Measuring the Mechanical Properties of Body Tissues - Basic Structural Analysis; Biomechanical Characteristics of Bone - Bone Tissue Function, Composition of Bone Tissue, Macroscopic Structure of Bone, Bone Formation; Mechanical Properties of Bone - Strength and Stiffness of Bone, Loads Applied to Bone, Stress Fractures; Cartilage and Ligaments - Articular Cartilage, Fibro cartilage, Ligaments; Bony Articulations - The Diarthrodial or Synovial Joint, Other Types of Joints, Osteoarthritis.
Unit 3	Muscular consideration for movement: Muscle Tissue Properties – Irritability, Contractility, Extensibility, Elasticity; Functions of Muscle - Produce Movement, Maintain Postures and Positions, Stabilize Joints, Other Functions; Skeletal Muscle Structure – Physical organization of muscle, Types of muscles; Force Generation in the Muscle - Motor Unit, Muscle Contraction, Transmission of Muscle Force to Bone; Mechanical Model of Muscle - The Musculo tendinous Unit.
Unit 4	Role of Muscle - Origin versus Insertion, Developing Torque, Muscle Role versus Angle of Attachment, Muscle Actions Creating, Opposing,, and Stabilizing Movements, Net Muscle Actions, One- and Two-Joint Muscles; Force–Velocity Relationships in Skeletal Muscle - Force–Velocity and Muscle Action or Load, Factors Influencing Force and Velocity Generated by Skeletal Muscle; Strengthening Muscle - Principles of Resistance Training, Training Modalities; Injury to Skeletal Muscle - Cause and Site of Muscle Injury, Preventing Muscle Injury, Inactivity, Injury, and Immobilization, Effects on Muscle
Unit 5	Neurological consideration for movement: Nervous System – Motoneurons, Structure of the Motoneuron, The Motor Unit, Neural Control of Force Output; Sensory Receptors and Reflexes - Muscle Spindle, Golgi Tendon Organ, Tactile and Joint Sensory Receptors; Effect of Training and Exercise - Flexibility Exercise, Plyometric Exercise; Electromyography - The Electromyogram, Recording an Electromyographic Signal, Factors Affecting the Electromyogram, Analyzing the Signal, Application of Electromyography, Limitations of Electromyography

Course Code: MSBC 103		**Course Title:** FUNDAMENTAL BIOMECHANICS
Max Marks: 100	Semester 1	Credits: 4
	Internal : 25	External : 75
Learning Objectives	1. To study about biomechanical societies and their role 2. To study about kinematics concepts for analyzing human movements 3. To study about kinetic concepts for analyzing human movements 4. To study about linear kinematics of human movement 5. To study about angular kinematics of human movement 6. To provide the knowledge of linear kinetics as applied to human movement 7. To provide the knowledge of angular kinetics as applied to human movement 8. To study the basic calculations pertaining to kinematics and kinetic	
Learning Outcomes	1. Describe motion with precise, well-defined mechanical 2. Understand and quantify linear and angular characteristics of motion 3. Understand the quantitative relationships between angular and linear motion 4. Characteristics of a rotating body 5. Understand and quantify the cause and effect relationship between force and linear and angular motion 6. Understand the mechanics of human body on water	
Suggested readings	*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.*	
Unit 1	Biomechanics – Sports Biomechanics- branches of biomechanics; statics, dynamics, kinematics, kinetics-Definition - Meaning - Scope - Need and importance of Biomechanics -Historical development of Sports Biomechanics - Scholarly societies-International Journal of sports Biomechanics-International society of Biomechanics-American society of biomechanics-Canadian society of biomechanics-European society of biomechanics- AAPHERD-ACSM-Journals in Biomechanics.	
Unit 2	Kinematic concepts for analyzing human movement: Kinematics; linear and angular kinematics- distance, displacement, speed, velocity and acceleration-forms of motion, linear motion, angular motion and general motion- tools for measuring kinematic quantities- common units of kinematic quantities Kinetic concepts for analyzing human movement: Inertia, mass, force, net force, centre of gravity, weight, pressure, volume, density, specific weight, torque, impulse- common units of kinetic quantities- mechanical loads on the human body; compression, tension and shear force- mechanical stress' torsion, bending and	

	combined loads- scalar, vector, composition and resolution, graphic solutions of vector problems trigonometric solutions of vector problems- tools for measuring kinetic quantities
Unit 3	Linear kinematics of human movement: Linear kinematics- kinematics of projectile motion; horizontal and vertical components, influence of gravity, influence of air resistance- factors affecting projectile trajectory; projection angle, projection speed, relative height of release, optimum projection conditions, analysing projectile motion, equations of constant acceleration Angular kinematics of human movement: Angular kinematics- measuring angles- relative and absolute angle-tools for measuring body angles- instant centre of rotation- angular kinematic relationship-; angular distance and displacement, angular speed and velocity, angular acceleration- relationship between linear and angular motion; linear and angular displacement, linear and angular velocity, linear and angular acceleration
Unit 4	Linear kinetics of human movement - Newton laws; Law of inertia, law of acceleration and law of acceleration- law of gravitation mechanical behaviour of bodies in contact; friction, static friction, kinetic friction, coefficient of friction- momentum – impulse- impact- coefficient of restitution- work, power and energy relationship- conservation of mechanical energy- principle of work and energy Equilibrium and human movement Torque, moment arm, couple, resultant joint torque, levers; types of levers, anatomical and mechanical levers- equations of static equilibrium- equations of dynamic equilibrium, centre of gravity and location of centre of gravity, location of human body centre of gravity; reaction board, segmental method- stability and balance Angular kinetics of human movement - 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 laws of motion- centripetal force and centrifugal force
Unit 5	Human movement in a fluid medium - The nature of fluids; fluid, relative motion, relative velocity, laminar and turbulent flow, fluid properties- buoyancy; characteristics of buoyant force, Archimedes's principle, centre of volume, floatation- drag, coefficient of drag, skin friction, surface drag, viscous drag, form drag, profile drag, pressure drag, wave drag- lift force, coefficient of lift, foil, Bernoulli principle, angle of attack, lift drag ration- Magnus effect- Propulsion in fluid medium, propulsive drag theory, propulsive lift theory, vortex generation and stroke technique Basic mathematic and related skills - Negative numbers, exponents, square roots, order of operations, use of a calculator, percentages, simple algebra, measuring angles, trigonometric functions, common units of measurement, anthropometric measurements for the human body.

Course Code: MSBC 104		**Course Title:** FUNCTIONAL ANATOMY
Max Marks: 100	Semester I	Credits: 4
	Internal : 25	External : 75
Learning Objectives	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
Learning Outcomes	1. Understand the scaplohumeral rhythm in an arm movement 2. Identify the muscular actions contributing to shoulder, wrist, fingers, hip, ankle, foot and vertebral column 3. Alterations in the alignment in the upper and lower extremities on sports performance 4. Understand the movement relationship between the pelvis and the lumbar vertebrae for the full range of trunk movement 5. Understand the importance of strength and flexibility of the muscles to perform actions without injury
Suggested readings	Joseph Hamill, Kathleen M. Knutzen, Timothy R. Derrick, (2015). Biomechanical Basis of Human Movement (4th edition); Lippincott Williams & Wilkins, Philadelphia, USA
Unit 1	The 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	The 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	The Pelvis and Hip Complex - 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

Students have to select any one course in Discipline Specific Elective Course given below.

Course Code: MSBE 105 Discipline Specific Elective		**Course Title:** A. FOUNDATION OF STRENGTH TRAINING AND CONDITIONING
Max Marks: 100	Semester I	Credits: 4
	Internal : 25	External : 75
Learning Objectives	Understanding the role of different types of exercise on various physiological systems and their contributions to enhance athletes sports performance	
Learning Outcomes	The methods involved in preparing an athlete or a personal trainer will be facilitated through on completion.	
Suggested readings	Nicholas Ratamess. (2012). ACSM's foundations of strength training and conditioning, American College of Sports Medicine, 401 W. Michigan St., Indianapolis, IN, USA.	
Unit 1	Introduction to strength training and conditioning - brief history of strength training and conditioning, competitive lifting sports, benefits of resistance training, fitness components, skill-related components of fitness, keys to success: the resistance training program, competitive forms of resistance training, Biomechanics of Force Production.	
Unit 2	Physiological Responses and Adaptations - Neural Adaptations to Training, Muscular Adaptations to Training, Connective Tissue Adaptations to Training, Endocrine System Responses and Adaptations, Metabolic Responses and Adaptations to Training, Responses and Adaptations of the Cardiorespiratory System, Principles of Strength Training and Conditioning	
Unit 3	Strength Training and Conditioning Program Design - Warm-Up and Flexibility, Resistance Training Program Design , Resistance Training Equipment and Safety, Resistance Training Exercises.	
Unit 4	Strength Training and Conditioning Program Design - Plyometric Training, Sprint and Agility Training , Aerobic Training, Training Periodization and Tapering	

Unit 5	Assessment and Evaluation - Test selection and administration, assessment of health-related fitness components, assessment of skill-related fitness components

Course Code: MSBE 105		**Course Title:** B. BIOMECHANICS OF SPORTS INJURIES
Max Marks: - Elective	Semester I	Credits: -
	Internal : -	External : -
Learning Objectives	▪ Understand the injury to that occurs on bone, cartilage, muscle and ligament to movements. ▪ Understand how specific sports surfaces behave ▪ Understand the influence that sports surfaces have on injury ▪ 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 ▪ Understand the effects of technique on the occurrence of musculoskeletal injury in a variety of sports and exercises.	
Learning Outcomes	Knowledge to overcome different types of injury on various structures due to sports equipment and technique on injury	
Suggested readings	Bartlett, Roger. (1999). Sports biomechanics: preventing injury and improving performance, Routledge Punlications	
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: 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	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: 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

Generic Elective

Course Code:		**Course Title:**
Max Marks: 100	Semester II	Credits: 3
	Internal : 25	External : 75
Note	Students has to select *Generic Elective* from other Divisions in Department of Sports Sciences or from other Departments in University	

M.Sc. SPORTS BIOMECHANICS
(Semester II)

<table>
<tr><td colspan="2">Course Code: MSBC 201</td><td>Course Title: ADVANCED STATISTICS AND SCIENTIFIC DATA PROCESSING</td></tr>
<tr><td rowspan="2">Max Marks: 100</td><td>Semester II</td><td>Credits: 4</td></tr>
<tr><td>Internal : 25</td><td>External : 75</td></tr>
<tr><td>Learning Objectives</td><td colspan="2">1. Gain an understanding and appreciation of statistical theory and its application on sports biomechanics
2. Gain knowledge of various methods of analyzing and interpreting data relevant to sport biomechanics, and how to use commonly used methods of analyzing data
3. Gain knowledge on the appropriate interpretation of data collected in sport biomechanics
4. Gain critical thinking on the use of the appropriate statistical method to be incorporated in an experimental investigation in sport biomechanics</td></tr>
<tr><td>Learning Outcomes</td><td colspan="2">1. Understand the theories of statistical inferences and apply the appropriate statistical techniques in different settings to solve research problems
2. Use a statistical package such as SPSS to implement these statistical methods
3. Interpret the statistical output produced by SPSS in implementing these statistical methods
4. Write a report using APA format on the statistical analysis
5. To understand and describe fundamental concepts of storing and processing data in computer systems
6. To solve typical data processing problems in science using modern programming environments</td></tr>
<tr><td>Suggested readings</td><td colspan="2">1. Clarke, David H. Clarke, Harrison H. Research Process in Physical Education, New Jersey: Prentice Hall Inc. 1984.
2. Jerry R. Thomas, Jack K. Nelson and Stephen J. Silverman., Research Methods in Physical Activity (5th Ed), New York: Human Kinetics, 2005.
3. Chris Gratton and Ian Jones., Research Methods for Sports Studies, London: Routledge, Taylor & Francis Group, 2004.
4. John W. Best and James V. Kahn., Research in Education (9th Ed.,), New Delhi: Prentice Hall of India Pvt. 2006.</td></tr>
<tr><td>Unit 1</td><td colspan="2">Need of Statistics in Physical Education; Nature of Data: Four Levels of Data – Nominal, Ordinal Interval & Ratio; Graphical representation of Data: Line Diagram, Pie Diagram, and Bar Diagram Frequency Distribution: Frequency Polygon, Frequency Curve, Histrogram, Ogives. Application of Measures of Central tendency & variability and their characteristics. Relative and absolute variability, Coefficient of variation.</td></tr>
</table>

Unit 2	Two approach to Probability – Classical & Axiomatic; Addition Theorem & Multiplication Theorem, Calculation of Probabilities. Normal Distribution: Properties of Normal Curve, Skewness & Kurtosis, Problems based on Normal Distribution. Developing norms in the form of grading, Percentile Scale, T- Scale, Scales based on difficulty ratings.
Unit 3	Concept of correlation & regression – Scatter diagram, linear correlation, rank correlation. Liner regression equation with two variables. Partial correlation coefficients of first and second order. Multiple correlation coefficients involving three variables. Sampling distribution of Means, Standard Error of Mean, Interval estimates and Point estimates; Coefficients interval for mean. Testing of Hypothesis – Region of Acceptance & Region of Rejection null & alternative Hypotheses: Level of Significance, type I & Type II errors, one tailed & two tailed Tests, degrees of freedom, procedure in testing of hypothesis.
Unit 4	Large Sample test (z-test) for means for one sample and two samples; Small sample test (t-test) for means for one sample and two samples – dependent and independent samples, F-test. Chi- Square Test for goodness of fit and testing independence of attributes. One way Analysis of Variance, Post- hoc Tests – LSD & Scheffe.
Unit 5	Scientific data processing – fundamental data structures (variables, data types, lists, arrays, classes, files) to store scientific data; fundamental control structures (loops, conditions, if-statements, functions) for processing scientific data; reading of data from sensors or databases; converting data between different file formats; Linkage of data between different sources; validation of data; calculation of indicators; visualization of data.

LIST OF PRACTICAL

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 Code: MSBC 202		**Course Title:** KINESIOLOGY
Max Marks: 100	Semester II	Credits: 4
	Internal : 25	External : 75
Learning Objectives	1. To provide the basic concepts of Kinesiology. 2. To study about the importance of the foundational sub disciplines of Kinesiology 3. To study in detail about the muscles origin, insertion and action 4. To study the muscle structure, movements, and loads applied to skeletal system	
Learning Outcomes	1. Identify muscle action in basic exercises and sport activities. 2. Design a basic musculoskeletal exercise programs for clients. 3. Communicate knowledge in a variety of scientific formats. 4. Apply knowledge and skills to analyse muscle action in sport activities. 5. Model how anatomical arrangements affect movement function in exercise and sport.	
Suggested readings	*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.*	
Unit 1	Kinesiology, meaning, history, scope and importance- muscle fiber architecture- uni-joint, two joint and multi joint muscles factors affecting muscular force generation; force velocity relationship, length tension relationship, electromechanical delay - functional role of skeletal muscles- structure of shoulder joint and shoulder girdle - origin, insertion and action of shoulder joint muscles and shoulder girdle muscles- - common injuries of the shoulder- Exercise program to stretch and strengthen the shoulder joint muscles.	
Unit 2	Structure of elbow joint- and wrist joint - Origin, insertion and action of elbow joint and wrist joint muscles- common injuries of elbow and wrist- Exercise program to stretch and strengthen the elbow joint and wrist joint muscles.	
Unit 3	Structure of pelvic girdle and hip joint - Origin, insertion and action of pelvic girdle and hip joint muscles- common injuries of hip joint - Exercise program to stretch and strengthen the pelvic girdle and hip joint muscles.	
Unit 4	Structure of knee joint and ankle joint - Origin, insertion and action of knee and ankle joint muscles- common injuries of knee and ankle - Exercise program to stretch and strengthen the knee and ankle joint muscles joint muscles	

Unit 5	Structure of spinal column - Origin, insertion and action of spinal column muscles-Common injuries of spinal column-Exercise program to stretch and strengthen the spinal column muscles joint muscles.

Course Code: MSBC 203		**Course Title:** TECHNIQUES FOR RECORDING AND ANALYZING SPORTS MOVEMENTS
Max Marks: 100	Semester II	Credits: 4
	Internal : 25	External : 75
Learning Objectives	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	
Learning Outcomes	1. Confidence to handle state of art measurement devices for biomechanical testing 2. To plan, prepare, measure and analyse biomechanical experiments 3. To apply theoretical understanding and practical knowledge to specialized case studies 4. To evaluate state of the art biomechanical diagnostics in competitive sports as well as in recreation, rehabilitation and health scenarios 5. To create reasoned diagnostics / experimental studies for competitive sports and sports products	
Suggested readings	*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*	
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 procedures - 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	Electromography - 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

Course Code: MSBC 204		**Course Title:** JOINT RANGE OF MOTION AND MUSCLE LENGTH TESTING
Max Marks: 100	Semester II	Credits: 3
	Internal : 25	External : 75
Learning Objectives	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	
Learning Outcomes	1. To 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, 2. To understand advanced methods of biomechanical testing and to evaluate related up-to date research outcomes, 3. To read scientific publications in English and prove the understanding in presentations and discussions, 4. To explain and apply the principles of biomechanics, motor control and neuromechanics, 5. To apply the obtained knowledge to creatively solve problems relating to sport, exercise, human movement and rehabilitation, 6. To debate theories and techniques used in the fields of biomechanics, human movement and neuromechanical control.	

Suggested readings	1. Winter, Biomechanics and Motor Control of Human Movemnt. Wiley. 2. Enoka, Neuromechanics of Human Movement, Human Kinetics.
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, Historical Development and Complexity of Problem, 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, Density, Mass, and Inertial Properties, Direct Experimental Measures, Muscle Anthropometry, Problems Based on Anthropometric Data; Kinetics: Forces and Moments of Force, Biomechanical Models, Basic Link-Segment Equations—the Free-Body Diagram, Force Transducers and Force Plates, Bone-on-Bone Forces During Dynamic Conditions, Problems Based on Kinetic and Kinematic Data
Unit 3	Mechanical Work, Energy, and Power – Introduction, Efficiency, Forms of Energy Storage, 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 – Introduction, Axes Systems, Marker and Anatomical Axes Systems, Determination of Segment Angular Velocities and Accelerations, Kinetic Analysis of Reaction Forces and Moments; Synthesis of Human Movement – Introduction, Review of Forward Solution Models, Mathematical Formulation, System Energy, External Forces and Torques, Designation of Joints
Unit 4	Muscle Mechanics – Introduction, 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 – Introduction, The Support Moment Synergy, Medial/Lateral and Anterior/Posterior Balance in Standing, Dynamic Balance during Walking.

This course is offered for the students from other division in Department of Sports Sciences and from other Department in University

Course Code: MSBE 205		**Course Title:** PHYSICS IN SPORTS
Max Marks: 100	Semester II	Credits: 3
	Internal : 25	External : 75
Learning Objectives	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	
Learning Outcomes	1. Learn how speed and acceleration relate to sprinting 2. Understand how Newton's laws of motion determine the path of a football 3. Applying the principles of rotational motion to gymnastics, figure skating and diving 4. Learn what the optimum launch angle are for long jump and other sports projectiles 5. Apply basic aerodynamic principles to the javelin, ski jumping and swimming 6. Estimate the effect of wind speed, altitude, temperature, and equipment on various sports.	
Suggested readings	Ellen Kreighbaum and Katharine M. Barthels. (1985). Biomechanics: A Qualitative Approach for Studying Human Movement (Second Edition), Macmillan Publishing Company, New York, USA.	
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.	

Generic Elective

Course Code:		**Course Title:**
Max Marks: 100	Semester II	Credits: 3
	Internal : 25	External : 75
Note	Students has to select *Generic Elective* from other Divisions in Department of Sports Sciences or from other Departments in University (or) from other Faculty in University	

Practical - I

Course Code: MSBP 206		**Practical Title:** a. Force Plate c. Dynamometer d. EMG
Max Marks: 100	Semester II	Credit: 03
	Internal : 40	External : 60

M.Sc. SPORTS BIOMECHANICS
(Semester III)

Course Code: MSBC 301		**Course Title:** DYNAMICS OF GAIT
Max Marks: 100	Semester III	Credits: 4
	Internal : 25	External : 75
Learning Objectives	1. To provide the knowledge of mechanical concepts as applied to human movement. 2. To study about gait analysis of dynamic movements 3. To study the three dimensional motion analysis of human movement 4. To study about clinical gait analysis	
Learning Outcomes	1. Demonstrate an objective and scientific approach to the study of human motion 2. Critically analyse human movement to be able to identify normal normal and pathological gait function and the parameters integral to successful movement execution 3. Identify and explain biomechanical factors during human motion that interact and contribute to mechanism of sporting injury 4. Describe how the biomechanical properties of tissue adapt to loading 5. Explain and apply the principles of kinetic and kinematic data collection and analysis of various biomechanical methods and equipment 6. Critically analyse biomechanical data on a movement task and author a research report that provides the appropriate recommendations aimed at improving performance, reducing the likelihood of injury and/or enhancing rehabilitation	
Suggested readings	1. Levangie PK, Norkin CC; Joint Structure & Function- A Comprehensive Analysis; Jaypee brothers, New Delhi; 2006. 2. Kapandji IA; The Physiology of Joints; Churchill Livingstone, Edinburgh; 1998. 3. Magee J D. orthopedic physical assessment. W.B. saunders ompany. 4. Grisaffi D. Posture and core conditioning Published by David Grisaffi and Personal Fitness Development in the United States of America. 5. Kendall, F. P., Mccreary, E. K., & Provance, P. G. (1993). Muscles Testing and Function (4th Ed). Baltimore: Williams &Wilkins. 6. Frank C C., Lardner assessment and treatment of muscle imbalance, human kinetics.	
Unit 1	Normal Gait - Walking and gait, History, Terminology used in gait analysis, Outline of the gait cycle, The gait cycle in detail, Ground reaction forces, Support moment, Energy consumption, Optimization of energy usage, Starting and stopping, Other varieties of gait, Changes in Gait with Age	
Unit 2	Pathological and other abnormal gaits - Specific gait abnormalities, Walking aids Treadmill gait	
Unit 3	Methods of gait analysis - Visual gait analysis, Temporal and Spatial Parameters during Gait Measurement of Temporal and Spatial Parameters during Gait, Camera	

	Based Motion Analysis, Active marker systems,
Unit 4	Accelerometers, Gyroscopes, Magnetic Fields and Motion Capture Suits, Measuring Force and Pressure Pressure beneath the foot Measuring Muscle Activity Measuring Energy Expenditure Combined kinetic/kinematic systems
Unit 5	Applications of gait analysis - Clinical gait assessment, Conditions benefiting from gait assessment Future developments

Course Code: MSBC 302		**Course Title:** MATLAB
Max Marks: 100	Semester III	Credits: 4
	Internal : 25	External : 75
Learning Objectives	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	
Learning Outcomes	1. To understand the use of Matlab in order to analyse signals in the investigation of human movement 2. 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	
Suggested readings	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	
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

Course Code: MSBC 303		**Course Title:** KINANTHROPOMETRY
Max Marks: 100	Semester III	Credits: 3
	Internal : 25	External : 75
Learning Objectives	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	
Learning Outcomes	1. Demonstrate greater practical skills in a range of anthropometric measurements of stature, skeletal breadths, girths and skinfolds 2. Record, analyse and evaluate anthropometric measurements 3. Safely and effectively use instrumentation and equipment to assess and record human anthropometry, physique and somatotype	
Suggested readings	Roger Eston, Kinanthropometry and Exercise Physiology Laboratory Manual: Tests, Procedures and Data: Volume One: Anthropometry (Volume 1) 3rd Edition.	
Unit 1	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 impedanceanthropometric 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 crestsupraspinale- subscapular-tricpeps-biceps-patella-mid	

	thighproximal 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.

Course Code: MSBC 304		**Course Title:** STRENGTH AND CONDITIONING AND APPLICATION OF BIOMECHANICS
Max Marks: 100	Semester III	Credits: 3
	Internal : 25	External : 75
Learning Objectives	1. Main tests and analysis for the determination of an athletes physical performance, mainly in the field of strength diagnostics. 2. Evaluation of the specific physiological needs of different types of sports. 3. Planning and performing of specifically adopted tests. 4. Presentation of results and how to communicate scientifically high end methods to athletes or coaches. 5. Specific sports scenarios and athletes needs to enhance performance.	
Learning Outcomes	1. Understand the principals of analysis of physical performance in competitive sports 2. Apply practical tests for strength and conditioning and evaluate outcomes for specific sports. 3. Understand, present and discuss scientific articles on recent developments in performance analysis, strength and conditioning. 4. Discuss the need of scientific support and development for competitive/ elite sports. 5. Evaluate applications of appropriate methods for kids, elderly, and health and rehabilitation scenarios. 6. Design and conduct a research project for strength and conditioning assessments in competitive/ elite sports. 7. Communicate/ present scientifically high-end methods and results to athletes or coaches	
Suggested readings	Baechle TR, Earle RW. *Essentials of Strength Training and Conditioning* (3rd edition) Champaign, IL: Human Kinetics 2008: 127-128	

Unit 1	**Unit-I** The Principles of Training, Progression, Specificity, Overload, Reversibility, Physiological Adaptations to Anaerobic Training, Muscular - Hypertrophy and Force Production, Energy Production Capacity of the Muscle, Specific Fiber Type Adaptations
Unit 2	**Unit-II** Resistance Training and Spotting Techniques – Equipment: Body Weight Exercises, Free Weights, Variable Resistance Machines, Isokinetic Equipment; Exercise and Spotting – Technique, Upper Body Exercises, Lower Body Exercises, Explosive Lifts
Unit 3	**Unit-III** Resistance Training Programming for General Fitness - Exercise Selection, Training Intensity and Frequency, Special Populations; Resistance Training Programming for Performance Enhancement - Training Protocol, Exercise Selection, Training Intensity and Frequency, Periodization.
Unit 4	**Unit-IV** Training for Power, Speed, and Agility - Plyometric Training, Speed Training, Agility Training
Unit 5	**Unit-V** Introduction, Review of Syllabus Structure and Function of Body Systems Biomechanics of Resistance Exercise, video of an athletic activity, complete analyse the exercise, identify the muscles involved, determine the types of contraction, determine the range of motion with respect to plane, determine the intensity, estimate the velocity from the start to end of the exercise, make sure the exercise performed are appropriate.

Students have to select any one course in Discipline Specific Elective Course given below.

Course Code: MSBE 305 Discipline Specific Elective		**Course Title:** A. HUMAN MOVEMENTS
Max Marks: 100	Semester I	Credits: 4
	Internal : 25	External : 75
Learning Objectives	1. Understand the basic sports movements performed during an activity and to avoid injury related movements through biomechanical analysis.	
Learning Outcomes	1. Understand the balance, toppling, slipping, falling and landing mechanism during competitive sports 2. Understand the mechanism of walking, running, jumping, throwing, striking, and catching while playing sports and games. 3. Understand the applications of Climbing, Swinging, and airborne manoeuvres in sports	
Suggested readings	Chapman, Arthur E (2008). Biomechanical analysis of fundamental human movements. Human Kinetics, Champaign, IL USA.	
Unit 1	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 - 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 - 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 - 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 - 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.

Course Code: MSBC 305		**Course Title:** B. METHODS IN NEUROMECHANICS
Max Marks: - Elective	Semester I	Credits: -
	Internal : -	External : -
Learning Objectives	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	
Learning Outcomes	1. To 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, 2. To understand advanced methods of biomechanical testing and to evaluate related up-to date research outcomes, 3. To read scientific publications in English and prove the understanding in presentations and discussions, 4. To explain and apply the principles of biomechanics, motor control and neuromechanics, 5. To apply the obtained knowledge to creatively solve problems relating to sport, exercise, human movement and rehabilitation, 6. To debate theories and techniques used in the fields of biomechanics, human movement and neuromechanical control.	
Suggested readings	1. Winter, Biomechanics and Motor Control of Human Movemnt. Wiley. 2. Enoka, Neuromechanics of Human Movement, Human Kinetics.	
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, Historical Development and Complexity of Problem, 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, Density, Mass, and Inertial Properties, Direct Experimental Measures, Muscle Anthropometry, Problems Based on Anthropometric Data; Kinetics: Forces and Moments of Force, Biomechanical Models, Basic Link-Segment Equations—the Free-Body Diagram, Force Transducers and Force Plates, Bone-on-Bone Forces During Dynamic Conditions, Problems Based on Kinetic and Kinematic Data	

Unit 3	Mechanical Work, Energy, and Power – Introduction, Efficiency, Forms of Energy Storage, 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 – Introduction, Axes Systems, Marker and Anatomical Axes Systems, Determination of Segment Angular Velocities and Accelerations, Kinetic Analysis of Reaction Forces and Moments; Synthesis of Human Movement – Introduction, Review of Forward Solution Models, Mathematical Formulation, System Energy, External Forces and Torques, Designation of Joints
Unit 4	Muscle Mechanics – Introduction, 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 – Introduction, The Support Moment Synergy, Medial/Lateral and Anterior/Posterior Balance in Standing, Dynamic Balance during Walking.

Generic Elective

Course Code:		**Course Title:**
Max Marks: 100	Semester II	Credits: 3
	Internal : 25	External : 75
Note	Students has to select *Generic Elective* from other Divisions in Department of Sports Sciences or from other Departments in University	

Practical - II

Course Code: MSBP 306		**Practical Title:** Gait, Strength and Conditioning Analysis, MATLAB
Max Marks: 100	Semester III	Credit: 03
	Internal : 40	External : 60

Internship

Course Code: MSBI 307		**Practical Title:** a. INTERNSHIP
Max Marks: 100	Semester III	Credit: 02
	Internal : 100	External : 00

M.Sc. SPORTS BIOMECHANICS
(Semester IV)

<table>
<tr><td colspan="2">Course Code: MSBC 401</td><td>Course Title: BIOMECHANICAL ANALYSIS OF ATHLETICS AND TEAM GAMES</td></tr>
<tr><td rowspan="2">Max Marks: 100</td><td>Semester IV</td><td>Credits: 4</td></tr>
<tr><td>Internal : 25</td><td>External : 75</td></tr>
<tr><td>Learning Objectives</td><td colspan="2">1. Latest developments and scientific research on performance analysis in competitive sports.
2. Specific sports scenarios and athletes needs to enhance performance biomechanically</td></tr>
<tr><td>Learning Outcomes</td><td colspan="2">1. Be able to explain performance analysis in game sports and its applications in game sports theory as well as game sports training.
2. Be able to explain theoretical innovations in game sports analysis including the mathematical background.
3. Be able to apply technological innovations in game sports analysis to questions of theoretical as well as practical performance analysis.</td></tr>
<tr><td>Suggested readings</td><td colspan="2">1. Hay, J. (1993). The Biomechanics of Sports Techniques, Benjamin Cummings.
2. McGinnis, Peter M. Biomechanics of Sport and Exercise, Human Kinetics, 2005.
3. Clarke, David H. Clarke, Harrison H. Research Process in Physical Education, New Jersey: Prentice Hall Inc. 1984.
4. Jerry R. Thomas, Jack K. Nelson and Stephen J. Silverman., Research Methods in Physical
Activity (5th Ed), New York: Human Kinetics. 2005.
5. Chris Gratton and Ian Jones., Research Methods for Sports Studies, London: Routledge, Taylor & Francis Group, 2004.
6. John W. Best and James V. Kahn., Research in Education (9th Ed.,), New Delhi: Prentice Hall of India Pvt. 2006.
7. Robertson .E Gordon D et al. Research Methods in Biomechanics. New York: Human Kinetics. 2004.</td></tr>
<tr><td>Unit 1</td><td colspan="2">Track events (Sprint - 100m, 200m and 400m)
History, legends, world record, skills, technique, application of biomechanical principles,
analysis of related research reviews, and analysis of current world and Olympic record holder’s performance. Types of Crouch Start – Bunch start-Medium start-Elongated start - Running – Stride length - Take-off distance - Flight distance - Landing Distance - Stride Frequency - Action of leg - Supporting phase-Driving phase - Recovery phase - Action of arms -Action of trunk - Finish - Types of Finish - Start - Running – Finish- Spikes – Types of spikes – Starting block
Middle and Long Distance and Relays (800m, 1500m, 5000m, 10000m , and 4x100m and
4x400m)
History, legends, world record, technique, application of biomechanical principles, analysis of related research reviews, and analysis of current world and Olympic record holder’s performance.</td></tr>
<tr><td>Unit 2</td><td colspan="2">Hurdles (100m, 110m and 400m hurdles)
History, legends, world record, technique, application of biomechanical principles,</td></tr>
</table>

	analysis of related research reviews, and analysis of current world and Olympic record holder's performance. Hurdles – High hurdles-Approach-take-off-Flight-Landing- Running between hurdles-Intermediate hurdles-Low hurdles
Unit 3	**Throws** (Shot-put, hammer, discus and javelin) History, legends, world record, technique, application of biomechanical principles, analysis of related research reviews, and analysis of current world and Olympic record holder's performance. **Shot-put -** Shot-put - O'Brien style-Initial stance-Glide-Delivery-Reverse - Rotation style- distance prior to release-Physique-Position-Distance after release-Height of release-Speed of release-Forces exerted - Angle of release –Air resistance - Advantages and Disadvantages of O'Brien and Rotation techniques. **Hammer -** Hammer Throw – Preliminary swing-The first turn-The second turn-The third turn-The delivery-Air resistance Speed of release-Angle of release-Height of release. **Discus -** Discus Throw – Initial stance – Preliminary swings-Transition-Turn-Delivery-reverse-Aerodynamic factors. **Javelin-**Javelin Throw – Types of Grip –Carry- Run – Transition, Throw, and Recovery-Speed, Angle, Height of release-Aerodynamic factors influencing flight-Advantages and Disadvantages of different Grips-Aerodynamic Javelin.
Unit 4	**Jumps** (Long jump, Triple jump, High jump and Pole vault) History, legends, world record, technique, application of biomechanical principles, analysis of related research reviews, and analysis of current world and Olympic record holder's performance. **Long Jump-**Hang style - Hitch Kick style - Approach run – Take-off -Flight in the Air - Landing – Take-off distance-Flight distance-Speed, angle, height of take off-air resistance-Advantages and Disadvantages of different styles. **Triple Jump -** Hop - Step and Jump- Approach Run – Take-off - Flight in the Air – Landing.
Unit 5	**Basketball, Handball, Volleyball, Kabaddi, Badminton, Squash, hockey, football, cricket, boxing, fencing, gymnastics, golf, cycling and swimming -** History of the game, legends, skills and technique, application of biomechanical principles, analysis of skills related each games and sports.

Course Code: MSBC 402		**Course Title:** APPLICATION OF BIOMECHANICS TO PHYSIOLOGICAL SYSTEMS
Max Marks: 100	Semester IV	Credits: 4
	Internal : 25	External : 75
Learning Objectives	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.	
Learning Outcomes	1. Develop a better understanding of how mechanical principles influence physiological systems during everyday life. 2. Analyze the forces of various biological systems during static and dynamic	

	human activities; analyze the stresses and strains in biological tissues. 3. Understand the principles of mechanics that is used to analyze biological systems.
Suggested readings	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
Unit 1	Exercise Limitations, Introduction, 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 – Introduction, 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 – Introduction, 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.

Course Code: MSBC 403		**Course Title:** BIOMECHANICS OF ASANAS
Max Marks: 100	Semester IV	Credits: 4
	Internal : 25	External : 75
Learning Objectives	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	
Learning Outcomes	1. Discover yoga to maintain or improve lifelong health and fitness 2. Develop a better understanding of how mechanical principles influence yogic movements with health perspective. 3. Analyze the stresses and strains in biological tissues by performing static and dynamic yoga asana	
Suggested readings	Francoise et al. Yoga and Pilates for everyone, Joanna lawrenz, 2006	
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	

Course Code: MSBD 404		**Course Title:** PROJECT WORK INCLUDING PRESENTATION, COMPREHENSIVE VIVA (RELATED TO THEIR SPECIALIZATION SELECTED)
Max Marks: 100	Semester IV	Credits: 4
	Internal : 25	External : 75

Practical - III

Course Code: MSBP 405		**Practical Title:** a. BIOMECHANICAL ANALYSIS OF TECHNIQUE IN TRACK AND FIELD AND TEAM GAMES b. BIOMECHANICAL ANALYSIS OF ASANAS
Max Marks: 100	Semester IV	Credit: 03
	Internal : 40	External : 60

Field Visit

Course Code: MSBV 406		**Practical Title:** Field Visit
Max Marks: 100	Semester IV	Credit: 01
	Internal : 100	External : 00