CURRICULUM DIVISION, HEC

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Mr. Rizwan Shoukat  Deputy Director (Curri.)
Mr. Abid Wahab  Assistant Director (Curri.)
Mr. Riaz-ul-Haque  Assistant Director (Curri.)
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Composed by: Mr. Zulfiqar Ali, HEC, Islamabad
PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII, vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “Supervision of Curricula and Textbooks and Maintenance of Standard of Education”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs), which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education, which is at par with international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 & 2009.

It is hoped that this curriculum document, prepared by the respective NCRC’s, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx

(Fida Hussain)
Director General (Academics)
CURRICULUM DEVELOPMENT PROCESS

Abbreviations Used:
CRC. Curriculum Revision Committee
VCC. Vice Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations
MINUTES OF THE FINAL MEETING:

In continuation to the preliminary meeting of National Curriculum Revision Committee in the discipline of Marine Science, which was held at Pakistan Marine Academy, Karachi from February 29 to March 2, 2016, final meeting of the NCRC was held during May 30 - June 01, 2016 at HEC Regional Centre, Karachi. The objective of the meeting was to finalize the preliminary draft of BS Marine Science curriculum for circulation by the HEC. The following attended the meeting:-

1. **Prof. Dr. Rashida Qari**
   Convener
   Director,
   Institute of Marine Science,
   University of Karachi,
   University Road, Karachi-75270

2. **Prof. Dr. Naureen Aziz Qureshi**
   Member
   Vice Chancellor,
   Government College Women University,
   Faisalabad.

3. **Dr. Javed Aftab**
   Member
   Senior Research Officer,
   (in lieu of Director General, NIO),
   National Institute of Oceanography,
   Karachi.

4. **Dr. Tariq Masood Ali Khan**
   Member
   Director,
   Institute of Environmental Studies,
   University of Karachi,
   University Road, Karachi-75270.

5. **Prof. Dr. Alia Bano Munshi**
   Member
   (in lieu of Director, CEMB)
   Centre of Excellence in Marine Biology (CEMB),
   University of Karachi,
   University Road, Karachi-75270.

6. **Capt. (PN) Mr. Fiaz Hussain TI (M)**
   Member
   Deputy Chief (Maritime),
   Ministry of Defence,
   Maritime Affairs Wing, Islamabad.

7. **Chief Engr. Rashid Yahya Usmani**
   Member
   Engineering Instructor,
   Pakistan Marine Academy,
   Hawks Bay Road, Maripur, Karachi.
8. **Dr. Ehsan Elahi Valeem**
Assistant Professor,
Institute of Marine Science,
University of Karachi,
University Road, Karachi-75270.

9. **Dr. Muhammad Aslam Buzdar**
Dean,
Faculty of Marine Sciences,
Lasbela University of Agriculture, Water & Marine Sciences,
Uthal, Balochistan.

10. **Dr. Azra Bano**
Assistant Professor,
Faculty of Marine Sciences,
Lasbela University of Agriculture, Water & Marine Sciences,
Uthal, Balochistan.

11. **Mr. Muhammad Tahir Khan**
Lecturer,
Faculty of Marine Sciences,
Lasbela University of Agriculture, Water & Marine Sciences,
Uthal, Balochistan.

12. **Mr. Syed Ghulam Qadir Shah**
National Coordinator,
International Union for Conservation of Nature,
IUCN-Pakistan, 1 Bath Island Road,
Karachi.

13. **Mr. Nadeem Mirbahar,**
National Resources Management Coordinator,
International Union for Conservation of Nature,
IUCN-Pakistan, 1 Bath Island Road,
Karachi.

The following members of the NCRC either attended or could not attend the meeting due to their official/ personal engagement, however, they sent their representatives in the said or present meeting as mentioned above:-

1. **Prof. Dr. Ghazala Siddiqui**
Director,
Centre of Excellence in Marine Biology (CEMB),
University of Karachi,
University Road, Karachi-75270.

2. **Dr. Asif Inam**
Director General,
National Institute of Oceanography (NIO),
Karachi.
3. **Capt. Nasim Ahmad Tariq**  
Nautical Instructor,  
Pakistan Marine Academy,  
Hawks Bay Road, Maripur, Karachi.

4. **Mr. A. Najeeb Bhatti**  
Chief Education Officer,  
Pakistan Marine Academy,  
Hawks Bay Road, Maripur, Karachi.

5. **Mr. Tahir Jameel**  
Chief Engineer,  
Pakistan Marine Academy,  
Hawks Bay Road, Maripur, Karachi.

The meeting started with recitation of Holy Verses from the Holy Quran by Dr. Ehsan Elahi Valeem, Deputy Convener (NCRC). Mr. Riaz-ul-Haque, Assistant Director (Curriculum), HEC on behalf of the Chairman, the Executive Director, HEC and Director General (Acad.), welcomed the participants and thanked all the members of the Committee for sparing precious time to participate in the meeting. He briefed the participants on the aim and objectives of the meeting with a particular focus on revising the curriculum of BS Marine Science - 2011. Mr. Sulaiman Ahmed, Director, HEC Regional Centre, Karachi while inaugurating the proceedings, appreciated the participants for their commitment to this task of national importance and assured full support from his team of HEC Regional Centre, Karachi.

The members of the Committee showed confidence on previously selected Convener, **Prof. Dr. Rashida Qari**, Director, Institute of Marine Science, University of Karachi, Deputy Convener, **Dr. Ehsan Elahi Valeem**, Assistant Professor, Institute of Marine Science and Secretary, **Mr. Muhammad Tahir Khan**, Lecturer, Faculty of Marine Sciences Lasbela University of Agriculture, Water & Marine Sciences, Uthal. The Convener thanked the participants for their confidence and started proceedings of the meeting in accordance with the agenda. The Committee started the revision process from the finalization of various modules for specialization in Marine Science programme. New modules like Integrated Coastal Zone Management (ICZM), Mangrovelogy, and Port Operations and Ship Management were added to provide more job opportunities to the students studying Marine Science.

The Committee reviewed and discussed the preliminary curriculum in detail and taking into account various aspects/demand of the discipline and various issues highlighted by the faculty member and other stakeholders. After detailed discussion the inputs/suggestions given by the members of the Committee were incorporated, where necessary, in the draft curriculum. New books were added and the contents were updated. After detailed and exhaustive discussion, the Committee finalized the layout of courses in the light of recommendations of all the participants and the guidelines provided by the HEC.
The Convener and the Secretary of the NCRC thanked the NCRC members for their inputs and worth mentioned Deputy Convener Dr. Ehsan Elahi Valeem for his contribution in finalizing the draft curriculum keeping in view the requirement of the country and to make it more practical, competitive and effective. The Committee highly appreciated the efforts vested by Mr. Sulaiman Ahmed, Director, HEC Regional Centre, Karachi and his staff for providing local hospitality and comfortable stay during three days meeting and Mr. Riaz-ul-Haque for his coordination.

Mr. Riaz-ul-Haque, Assistant Director (Curriculum) thanked the Convener, the Deputy Convener, the Secretary and all the members of the committee for sparing precious time and for their quality contribution towards accomplishment of revision process of the curriculum in Marine Science through NCRC.

The meeting ended with the vote of thanks to and from the chair as well as the participants of the meeting.

**Rationale of BS in Marine Science:**

Placed in the north-western part of Indian Subcontinent, Pakistan borders the Arabian Sea with a sizeable coastline running for approximately 990 km in the east-west direction. Nearly 320 km of this seashore falls in the province of Sindh whereas the rest of 670 km constitute the Makran coast. The Exclusive Economic Zone, that stretches 350 nautical miles seaward from the coast, provides 290,000 km$^2$ area of the Arabian Sea for exploitation of the renewable and non-renewable resources, on which coastal population of the Sindh and Balochistan provinces largely depends for their livelihood. Besides, a huge volume of raw materials, finished products and oil imported through the maritime trade as well as the exports of Pakistani products provides employment opportunities to thousands of families in both the provinces.

Marine scientists work on the sustainable use, development and conservation of marine and coastal environment. Growing world population emphasizes the ability of our society to produce food, energy and water from oceans to help sustain our basic needs. Advances in technology, will improve our ability to derive food, drinking water and energy sources from the oceans and use the same for waste disposal, and transportation. It will be up to us and our future generations to build upon our existing knowledge of oceans and their potential to help meet needs of the world and its inhabitants. Because of the growing concerns for the protection and prudent use of our natural resources, there is an increasing need for skilled personnel who can advise on, organize and control the development of marine resources and activities.

In view of the importance of Arabian Sea with respect to fishing, use of mangrove forest, its potential for offshore hydrocarbon exploration and import/export of goods through the ports of Karachi and Gawadar, makes it highly desirable that a fully devoted degree programme is launched in Marine Science in order to cater the need of appropriately trained and skilled manpower in this
field. BS Marine Science is a branch of Earth Science that studies almost everything related with oceans, seas, their coasts and seabed. It covers a wide range of topics including ocean currents, waves and tides; marine organisms and ecosystem dynamics; geophysical fluid dynamics; plate tectonics and geology of the sea floor including their minerals and hydrocarbon potential; and fluxes of various chemical substances and physical properties within the ocean and across its boundaries. These diverse topics relate to a multitude of disciplines like chemistry, physics, biology, geology, meteorology and geography that oceanographers blend together to comprehend knowledge of the world oceans and processes within it. Marine science is a contemporary field of education having emerged as a hybrid of traditional fields such as biology, chemistry and geology forming biogeochemistry.

The BS Marine Science programme will enrol such students who have completed 12 years of studies with traditional science courses as biology, chemistry, physics, and mathematics. It integrates science curricula so as to provide a thorough understanding of the related earth and life science education in the realm of oceans. The curriculum is designed to provide standard marine science education in Pakistan that can be divided into following branches and electives in each module:

- **Biological Oceanography and Conservation:** Biological Oceanography or Marine Biology is the study of plants, animals and microbes of the ocean and their ecological interaction with the habitat and Conservation Biology is the scientific study of nature and of Earth’s biodiversity with the aim of protecting species, their habitats, and ecosystems from excessive rates of extinction and the erosion of biotic interactions.

- **Chemical and Environmental Oceanography:** Chemical Oceanography or Marine Chemistry is the study of ocean chemistry, the behaviour of the chemical elements within the Earth’s oceans. The ocean is unique in that it contains - in greater or lesser quantities - nearly every element in the periodic table, which interacts with the atmosphere. Environmental Oceanography or Environmental Science is the study of the interactions among the physical, chemical and biological components of the environment; with a focus on pollution and degradation of the environment related to human activities; and the impact on biodiversity and sustainability from local and global development.

- **Fisheries and Aquaculture:** Fisheries may involve the capture of wild fish or raising fish through fish farming or aquaculture. It provides science-based conservation and management for sustainable fisheries and aquaculture, marine mammals, endangered species, and their habitats. Aquaculture, also known as aqua-farming, is the farming of aquatic organisms such as fish, crustaceans, molluscs and aquatic marine organisms. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish.
• **Geological Oceanography**: Geological Oceanography or Marine Geology studies the structure and morphology of the ocean floor, tectonic activity and volcanism associated with plate margins, continental margins, beaches and coastal areas, sediment transport and deposition regimes, and offshore mineral and hydrocarbon deposits *etc.*

• **Integrated Coastal Zone Management (ICZM)**: Integrated Coastal Zone Management (ICZM) or Integrated Coastal Management (ICM) is a process for the management of the coast using an integrated approach, regarding all aspects of the coastal zone, including geographical and political boundaries, in an attempt to achieve sustainability.

• **Mangrovology**: Mangrovology is the study of mangroves including flora and fauna inhabiting the Mangrove roots (Pneumatophores) as epiphytes, endophytes, epifauna and endofauna respectively. Mangrove habitats provide nursery grounds for a variety of juvenile organisms. Several economic activities are also associated with Mangroves environment, which are not only untapped but also unexplored. There is a need to plant Mangrove saplings on the wetlands to help them grow and foster other marine creatures. Mangrove Forests can also be developed into a precious ecotourism sights.

• **Physical Oceanography**: Physical Oceanography or Marine Physics studies the physical attributes of the oceans including temperature-salinity structure, mixing, waves, tides and currents, light and sound transmission *etc.*

• **Port Operations and Ship Management**: Maritime transport is the shipment of goods (cargo) and people by sea and other waterways. Port operations are a necessary tool to enable maritime trade between trading partners. To ensure smooth port operations and to avoid congestion in the harbour it is inevitable to permanently upgrade the port’s physical infrastructure, invest in human capital, fostering connectivity of the port and upgrade the port operations to prevailing standards. Hence, port operations can be defined as all policies, reforms and regulations that influence the infrastructure and operations of port facilities including shipping services.

The programme of BS in Marine Science is aimed at preparing graduates for a range of interesting careers and opportunities. A marine scientist can be employed in federal, state and local government agencies to manage and monitor the use of resources, solve problems and conduct research better than anybody else. They can be employed by private industries such as seafood, fisheries, aquaculture, exploratory marine geology, satellite imagery, and ecological modelling, including environmental agencies and numerous non-government organizations.
STANDARDIZED TEMPLATE FOR FOUR-YEAR

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Category</th>
<th>No. of Courses Min - Max</th>
<th>Credit Hours (Crh) Min - Max</th>
<th>Percentage (%) of Crh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Compulsory Courses</td>
<td>9 - 9</td>
<td>25 - 25</td>
<td>18.4</td>
</tr>
<tr>
<td>2.</td>
<td>General Courses to be chosen from other departments</td>
<td>7 - 8</td>
<td>21 - 24</td>
<td>17.6</td>
</tr>
<tr>
<td>3.</td>
<td>Interdisciplinary Courses</td>
<td>6 - 8</td>
<td>18 - 24</td>
<td>17.6</td>
</tr>
<tr>
<td>4.</td>
<td>Module Specific Foundation Courses</td>
<td>10 - 11</td>
<td>30 - 33</td>
<td>24.3</td>
</tr>
<tr>
<td>5.</td>
<td>Major Elective Courses</td>
<td>8 - 10</td>
<td>24 - 30</td>
<td>22.1</td>
</tr>
<tr>
<td></td>
<td>5a. Research Project*</td>
<td>1 - 1</td>
<td>3 - 3</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>5b. Thesis/ Internship*</td>
<td>2 - 2</td>
<td>6 - 6</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>40 - 46</strong></td>
<td><strong>118 - 136</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Optional in lieu of major elective course/ courses.

BS IN MARINE SCIENCE

- Total numbers of Courses: 46 Courses
- Total numbers of credit hours (Crh): 136
- Duration: 4 years
- Semester duration: 16-18 weeks
- Semesters: 8
- Course load per semester: 15-18 Cr h
- Number of courses per semester: 4-6 courses

ELIGIBILITY FOR ADMISSION IN FOUR-YEAR BS PROGRAMME

Intermediate Science (or equivalent) with minimum 2nd division from the following groups as per preference of order given below:
1. Pre-Medical Group
2. Pre-Engineering Group
3. Other Groups (studied at least two subjects from Chemistry, Physics and Mathematics)
<table>
<thead>
<tr>
<th>Compulsory Courses</th>
<th>General Courses from Other Departments</th>
<th>Module Specific Foundation Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 courses</td>
<td>7-8 courses</td>
<td>10-11 courses</td>
</tr>
<tr>
<td>25 Credit hours (Crh) Subject</td>
<td>Crh</td>
<td>21-24 Credit hours Subject</td>
</tr>
<tr>
<td>Citizenship Education and Community Engagement/ Optional*</td>
<td>3</td>
<td>Computer Applications</td>
</tr>
<tr>
<td>English I</td>
<td>3</td>
<td>Fundamental of Economics</td>
</tr>
<tr>
<td>English II</td>
<td>3</td>
<td>General Biology</td>
</tr>
<tr>
<td>English III/ Urdu Information Technology Islamic Studies/ Ethics</td>
<td>3</td>
<td>General Chemistry General Geology</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>General Physics</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>General Physics</td>
</tr>
<tr>
<td>Pakistan Studies</td>
<td>2</td>
<td>Introduction to Sociology</td>
</tr>
<tr>
<td>Mathematics</td>
<td>3</td>
<td>Marine Biotechnology</td>
</tr>
<tr>
<td>Introduction to Statistics</td>
<td>3</td>
<td>Marine Resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>24</td>
<td>33</td>
</tr>
</tbody>
</table>

* University may opt any other subject.
**Major Elective Modules* including Research Project/ Internship**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Major Elective Modules</th>
<th>Crh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Biological Oceanography and Conservation (BOC)</td>
<td>30</td>
</tr>
<tr>
<td>2.</td>
<td>Chemical and Environmental Oceanography (CEO)</td>
<td>30</td>
</tr>
<tr>
<td>3.</td>
<td>Fisheries and Aquaculture (FA)</td>
<td>30</td>
</tr>
<tr>
<td>4.</td>
<td>Geological Oceanography (GO)</td>
<td>30</td>
</tr>
<tr>
<td>5.</td>
<td>Mangrovelogy (Mangl)</td>
<td>30</td>
</tr>
<tr>
<td>6.</td>
<td>Integrated Coastal Zone Management (ICZM)</td>
<td>30</td>
</tr>
<tr>
<td>7.</td>
<td>Physical Oceanography (PO)</td>
<td>30</td>
</tr>
<tr>
<td>8.</td>
<td>Port Operations and Ship Management (POSM)</td>
<td>30</td>
</tr>
</tbody>
</table>

**Option for Substitution**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Option</th>
<th>Crh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Field Project**</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>Thesis/ Internship***</td>
<td>6</td>
</tr>
</tbody>
</table>

* In the final year of BS only one module (of 10 courses) is to be chosen.

** Field Project may substitute one course (3 Crh) of a major elective module.

*** Thesis/ Internship may substitute two courses (6 Crh) of a major elective module within two semesters *i.e.* one subject each from 7th and 8th semester.
<table>
<thead>
<tr>
<th>Semester/ Year</th>
<th>Name of Subject</th>
<th>Crh</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Semester/ First Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE - 301</td>
<td>Citizenship Education and Community Engagement</td>
<td>3</td>
</tr>
<tr>
<td>Eng - 301</td>
<td>English-I</td>
<td>3</td>
</tr>
<tr>
<td>Biol - 301</td>
<td>General Biology</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>Chem - 301</td>
<td>General Chemistry</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>Maths - 301</td>
<td>Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MS - 301</td>
<td>Introduction to Marine Science</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
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<td><strong>Second Semester/ First Year</strong></td>
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<tr>
<td>Eng - 302</td>
<td>English-II</td>
<td>3</td>
</tr>
<tr>
<td>IslSt-302/ Eth-302</td>
<td>Islamic Studies/ Ethics</td>
<td>2</td>
</tr>
<tr>
<td>Geol - 302</td>
<td>General Geology</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>Phys - 302</td>
<td>General Physics</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>Stats - 302</td>
<td>Introduction to Statistics</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>MS - 302</td>
<td>Marine Ecology and Ecosystems</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td><strong>Third Semester/ Second Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eng-401/ Ur-401</td>
<td>English-III/ Urdu</td>
<td>3</td>
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<tr>
<td>Biostats - 401</td>
<td>Biostatistics</td>
<td>3</td>
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<tr>
<td>Comp - 401</td>
<td>Computer Applications</td>
<td>2+1 = 3</td>
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<tr>
<td>Sociol - 401</td>
<td>Introduction to Sociology</td>
<td>3</td>
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<tr>
<td>MS - 401</td>
<td>Marine Biochemistry</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>MS - 403</td>
<td>Marine Biotechnology</td>
<td>2+1 = 3</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td><strong>Fourth Semester/ Second Year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT - 402</td>
<td>Information Technology</td>
<td>3</td>
</tr>
<tr>
<td>PkSt - 402</td>
<td>Pakistan Studies</td>
<td>2</td>
</tr>
<tr>
<td>Econ - 402</td>
<td>Fundamental of Economics</td>
<td>3</td>
</tr>
<tr>
<td>MS - 402</td>
<td>Marine Microbiology</td>
<td>2+1 = 3</td>
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<tr>
<td>MS - 404</td>
<td>Marine Resources</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>MS - 406</td>
<td>Oceanographic Instruments and Methods</td>
<td>2+1 = 3</td>
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<td>17</td>
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</table>
### Fifth Semester/ Third Year

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MS - 501</td>
<td>Application of Remote Sensing and GIS</td>
<td>3</td>
</tr>
<tr>
<td>MS - 503</td>
<td>Hydrography</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>MS - 505</td>
<td>Marine Biodiversity</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>MS - 507</td>
<td>Coastal Processes</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>MS - 509</td>
<td>Marine Chemistry</td>
<td>2+1 = 3</td>
</tr>
<tr>
<td>MS - 511</td>
<td>Marine Geology</td>
<td>2+1 = 3</td>
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</table>

### Sixth Semester/ Third Year

<table>
<thead>
<tr>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS - 502</td>
<td>Climatology and Climate Change</td>
<td>3</td>
</tr>
<tr>
<td>MS - 504</td>
<td>Introduction to Aquaculture</td>
<td>3</td>
</tr>
<tr>
<td>MS - 506</td>
<td>Physical Oceanography</td>
<td>2+1 = 3</td>
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<td>MS - 508</td>
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<td>MS - 512</td>
<td>Research Methodology</td>
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### Seventh Semester/ Fourth Year

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### Eighth Semester/ Fourth Year

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### Optional for 7th and 8th Semester/ Fourth Year

<table>
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<tr>
<td>Thesis/ Internship</td>
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</table>
LIST OF MAJOR ELECTIVE MODULES AND COURSES THEREOF

Students are required to select one module consisting of 10 courses from eight modules given below in 7th and 8th semester. One course (3 Crh) may be substituted by a Field Project or two courses (3 + 3 = 6 Crh) i.e. one from each semester of an elective module by a thesis/Internship as the case may be. One or two courses of a module may also be substituted by the courses of other module. Some courses can be taught in more than one module*.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Elective Module/ Course</th>
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<tbody>
<tr>
<td><strong>Module I</strong></td>
<td>Biological Oceanography and Conservation (BOC)</td>
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<tr>
<td>MS-BOC - 601</td>
<td>Aquatic Pathology and Pests</td>
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<td>MS-BOC - 602</td>
<td>Biophysics</td>
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<td>MS-BOC - 603</td>
<td>Cell and Evolutionary Biology</td>
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<td>MS-BOC - 604</td>
<td>Chemistry of Life</td>
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<td>MS-BOC - 605</td>
<td>Conservation Ecology</td>
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<td>Faunistic Studies</td>
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<td>Harmful Marine Creatures</td>
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<td>Immunology</td>
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<td>Invertebrate Biology</td>
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<td>Physiology of Marine Organisms</td>
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<td>Planktology</td>
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<td>Marine Animal Behaviour</td>
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<td>Marine Botany</td>
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<td>Saline Agriculture</td>
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<td>Seafood Handling, Processing and Safety*</td>
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<td><strong>Module II</strong></td>
<td>Chemical and Environmental Oceanography (CEO)</td>
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<td>MS-CEO - 601</td>
<td>Bioremediation</td>
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<td>MS-CEO - 602</td>
<td>Environmental Impact Assessment</td>
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<td>MS-CEO - 603</td>
<td>Marine and Estuarine Chemistry</td>
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<td>Marine Biogeochemistry</td>
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<td>Marine Meteorology</td>
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<td>Marine Natural Product Chemistry</td>
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<td>MS-CEO - 608</td>
<td>Marine Pollution and Control</td>
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<td>Natural Hazards and Management</td>
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<td>MS-CEO - 610</td>
<td>Physical Chemistry</td>
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<td>Water Quality Management</td>
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<td>Module III</td>
<td>Fisheries and Aquaculture (FA)</td>
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<td>MS-FA - 601</td>
<td>Advanced Aquaculture</td>
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<td>Aquaculture Environment Management</td>
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<td>Aquaculture Health Management</td>
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<td>Aquaculture Nutrition</td>
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<td>Fisheries Economics and Marketing</td>
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<td>Fisheries Resources and Management</td>
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<td>Fisheries Techniques and Methods</td>
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<td>Fish Population Dynamics</td>
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<td>Hatchery Operation and Management</td>
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<td>MS-GO - 601</td>
<td>Coastal and Marine Sedimentology</td>
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<td>Geology of Arabian Sea</td>
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<td>Marine Geophysics and Exploration</td>
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<td>Ocean Basin Evolution</td>
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<td>Paleo-Oceanography</td>
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<td>Plate Tectonics and Coastal Structures</td>
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<td>Basic Principles and Scope of ICZM</td>
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<td>Coastal Ecosystem and Climate Change</td>
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<td>Coastal Resilience and Disaster Risk Reduction</td>
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<td>Marine Protected Areas Management</td>
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<td>Marine Spatial Planning &amp; Conflict Management</td>
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<td>Conservation of Mangrove Resources</td>
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<td>Ecological Mangrove Rehabilitation (EMR)</td>
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<td>Human Impact and Threats to Mangrove Ecosystem</td>
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<td>Productivity of Mangrove Wetlands</td>
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<td>Climate Change</td>
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<td>Marine Acoustics</td>
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<td>Natural Hazards and the Oceans</td>
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<td>Ocean Circulation and Climate</td>
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<td>Ocean Modelling and Numerical Methods</td>
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<td>Ocean Waves, Tides and Currents</td>
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<td>Satellite Oceanography</td>
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<th>Port Operations and Ship Management (POSM)</th>
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<tr>
<td>MS-POSM - 601</td>
<td>Business Research Methodology</td>
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<td>Fundamentals of Maritime, Economics &amp; Marketing</td>
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<td>International Conventions and Maritime Laws</td>
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<td>Marine and Maritime Employment</td>
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<td>Piloting and Navigation</td>
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<td>Port Development, Operations and Management</td>
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<td>Ship Brokerage, Chartering and E-commerce</td>
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<td>Shipping and Environment Norms</td>
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<td>Shipping Operations and Management</td>
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19
CITIZENSHIP EDUCATION AND COMMUNITY ENGAGEMENT

Objectives:

To understand the principles, ethics and core attitudes related to community participation. To develop an understanding of the complexity of community and to see the interconnectedness of local and global communities. To develop and improve skills for effective community engagement including but not limited to Reflection, Observation, Effective and purposeful communication, Team work, Conflict resolution, Organizational skills and Collaborative planning.

Course Outline:

This course explores the politics, processes and functioning of communities and provides foundational knowledge and skills for effective and principled community engagement. Regardless of your degree, you will be a member of many communities- your workplace, your professional group, your neighbourhood, your city, your country, the world. In the future, whether as a scientist, engineer, business professional, humanist, social scientist or health/ social services provider, you will be called upon to participate in community activities and community change.

Lab. Work:

This course is an interdisciplinary course where students are encouraged to be active participants. It will include mini-lectures, conversations, exercises and simulations. There should be at least one field trip. The course will be co-taught in order to students at least two disciplinary perspectives and will involve guest speakers from campus or community.

Recommended Books:

Objectives: Enhance language skills and develop critical thinking.

Course Contents:

Basics of Grammar. Parts of speech and use of articles. Sentence structure, active and passive voices. Practice in unified sentence. Analysis of phrase, clause and sentence structure. Transitive and intransitive verbs. Punctuation and spelling. Comprehension; Answers to questions on a given text

Discussion: General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students). Listening: To be improved by showing documentaries/ films carefully selected by subject teachers. Translation skills: Urdu to English. Paragraph writing: Topics to be chosen at the discretion of the teacher. Presentation skills: Introduction.

Note: Extensive reading is required for vocabulary building

Lab. Work:

Not Applicable.

Recommended Books:

Objectives:

The course provides wide range coverage to principles of life. Particular emphasis is on chemical basis of life and polymerization in carbohydrates, lipids, proteins and nucleic acids. The course will impart knowledge about enzymes and phenomenon of hereditary transformation in living organisms.

Course Outline:


Lab. Work:


Recommended Books:

Objectives:

The main objective of this course is to provide a basic knowledge and understanding of chemistry and principles of chemical reactions. The course not only provides excellent practice in basic chemistry, but also allows the rigorous development of experimental schemes and analysis methods, relying on physical chemistry and analytical reasoning.

Course Outline:


Lab. Work:


Recommended Books:

Objectives:

To prepare the students, not majoring in mathematics, with the essential tools of algebra, calculus, trigonometry and geometry to apply the concepts and the techniques in their respective disciplines.

Course Outline:

Preliminaries, Matrices, Quadratic Equations, Sequences and Series, Binomial Theorem, Trigonometry, Limits and Continuity, Derivatives and their Applications, Integration and Definite Integrals, Geometry in Two Dimensions, Circle and Conic Sections.

Lab. Work:

Not required.

Recommended Books:

Objectives:

To understand basics of Marine Science, its biological, geological, chemical and physical characteristics and interrelationship.

Course Outline:


Lab. Work:

Not required.

Recommended Books:

5. Severdrup, Johnson and Fleming, The Ocean.
Second Semester
Eng - 302
ENGLISH-II
3 Crh
(Communication Skills)

Objectives: Enable the students to meet their real life communication needs.

Course Contents:

Paragraph writing. Practice in writing a good, unified and coherent paragraph. Essay writing Introduction. CV and job application Translation skills Urdu to English. Study skills. Skimming and scanning, intensive and extensive, and speed reading, summary and precis writing and comprehension. Academic skills. Letter/ memo writing, minutes of meetings, use of library and internet Presentation skills. Personality development (emphasis on content, style and pronunciation). Note: documentaries to be shown for discussion and review.

Recommended Books:

3. Langan, J., Reading and Study Skills.
Objectives:
To provide Basic information about Islamic Civilization. To improve Student’s skill to perform prayers and other worships and enhance students understanding regarding issues related to faith and religion.

Course Outline:

Reference Books:
8. Khalifa Abdul Hakim, Islamic Ideology.
14. A.M.A. Shushtery, Outlines of Islamic Culture.
15. Hameedullah Muhammad, “Muslim Conduct of State”
Objectives:

This course is an introduction to moral philosophy and is intended for the student who has little or no prior exposure to philosophy. It provides a broad but reasonably detailed examination of the central issues of moral philosophy and also considers how these can be applied to several contemporary moral problems.

Course Outline:

Indication and scope of ethics: relation of ethics to psychology, metaphysics and religion. A brief review of major theories or the moral standard (The standard as Law, Happiness and as Perfection). Promotion of moral values in society through family & various educational and cultural Institutions; Concept of good and evil; Freedom and responsibility; Various theories of punishment. Ethical teachings of world religions with special reference to Hinduism, Christianity, Buddhism, Judaism and Islam. Hundred ethical precepts from the Quran and sayings of the Holy Prophet (Peace be upon him). Islam’s attitude towards minorities.

Lab. Work:

Not required.

Recommended Books:

1. **B.A. Dar, Quranic Ethics.**
3. **Harol H. Titus, Ethics for To-day.**
4. **J.S. Mackenzie, A Manual of Ethics.**
5. **Modudi, S. Islami Riyasat, Islamic Publications, Lahore.**
7. **Proceedings of to Islamic Colloquium, Lahore 1957.**
Objectives:

This course is designed to acquire the knowledge about the basic concepts of Geology. This will help the students to get knowledge about various types of rocks and minerals and the processes of their formation.

Course Outline:

Introduction and scope of geology, its importance and relationship with other sciences. Earth as a member of the solar system; its origin, age, composition and internal structure. Introduction to rocks and minerals. Introduction to plate tectonics, mountain building processes earthquake and volcanoes. Primary sedimentary, igneous and metamorphic structures. Introduction of folds, faults, joints, cleavage, foliation, lineation and unconformities. Weathering and erosion. Isostasy. Geological Time Scale.

Lab. Work:

Study of relief features with the help of models and topographic maps. Identification of rocks and minerals.

Recommended Books:

Objectives:

This course is designed to enable students to acquire basic understanding of the Physical world, its origin and structure to help the potential application of the unexplored and unidentified organisms in the industry.

Course Outline:


Lab. Work:

Specific experiments.

Recommended Books:

3. Tewari, K.K., Electricity and Magnetism, S. Chand & Co., Ltd.
Objectives:

To familiarize students with the statistical parameters necessary for the scientific presentation and drawing inferences.

Course Outline:


Lab. Work:

Exercises may be given.

Recommended Books:

Objectives:

To understand the basic functional definition of ecology and ecosystem.

Course Outline:


Lab. Work:

Field trips and reports, case studies of coastal ecosystems.

Recommended Books:

Objectives: To enhance language skills and develop critical thinking

Course Contents:


Note. Extensive reading is required for vocabulary building.

Lab. Work:

Not Applicable.

Recommended Books:

Objectives:

To enhance language skills and develop critical thinking in native language.

Course Outline:


Lab. Work:

Not Applicable.

Recommended Book:

Objectives:

To familiarize students with the statistical parameters necessary for the scientific presentation and drawing inferences of biological problems.

Course Outline:


Lab. Work:

Exercises may be given.

Recommended Books:

Objectives:

Computing technology is all around us in our everyday lives, from mobile phone to GPS system to networking website etc. Being intelligent, innovative and forward-thinking students can develop technology e.g. climate modelling, the study of diseases and ecology. As well as learning how computers work, the students will get an understanding of the technology behind computer games, mobile phones, the internet and many other computing-based products.

Course Outline:

**Computer programming, Essential mathematical skills.** Embedded Systems, Windows applications, web applications, console applications. System software: windows, file manager and linux etc. Software creation and invention new ways to use it. Computer games, mobile applications and the software that is contained in the devices we use on a daily basis. Application software: browsing software, word processing, multimedia, or spreadsheet software.

Lab. Work:

**Small projects may be given.**

Recommended Books:

Objectives:

To inculcate community participation and social interaction between students and the coastal community to help resolve their problems.

Course Outline:


Lab. Work:

Field based activities.

Recommended Books:

1. Anthropology: The Study of Man Adamson Hoebel, E.
3. Contemporary Sociological Theories Pitrim Sorokin.
5. Feudal System in Pakistan Nawab Haider Naqvi.
8. Pakistani Society Akbar Ahmad, S.
10. Social Change and History Robert Nisbet.
16. The Sociology of Rural Life Lynn Smith, T.
Objectives:


Course Outline:


Lab. Work:


Recommended Books:

Objectives:

To acquaint students with recent advancements in the field of marine biotechnology and how molecular techniques may be applied for studying marine organisms and to provide basic concepts and significance of biotechnology as it is being used in industry.

Course Outline:

Definition and history; foundations of biotechnology and interdisciplinary pursuit; introduction to marine microorganisms commonly used in industry and marine biotechnology; branches and/or applications of biotechnology in medicine, agriculture (algae, fungi, food, livestock and fisheries, etc.); primary and secondary metabolites (e.g., antibiotics, organic acids, toxins, etc.); aquaculture techniques; marine microbes and phytoplankton/ flora of biotechnological importance; role of marine microbes in global carbon cycling; recent progress in discovery of drugs and enzymes from marine sources; significance of microorganisms in food production, fermentation, pharmaceutical and other industries; protection of biotechnological products; media and nutritional requirements of industrial organisms; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world.

Lab. Work:

Isolation and screening of potential microbes from different environmental sources; lab scale production of bacterial enzymes; lab-scale production of alcohol by yeast; the use of microbes in bioleaching; use of microbes in microbial enhanced oil recovery.

Recommended Books:

Objectives:

To make students hand on computer devices and software.

Course Outline:

Types of Computers, Part of Computer, types of printers/ plotters, Storage Devices, Number Systems; Software: Operating Systems, Programming and Application Software, Operating Systems, Introduction to Programming, Databases and Information Systems, Networks, Data Communication, The Internet, Browsers and Search Engines; Accessing the Internet Application: connection through LAN connection through modem, connection through high-speed lines. The Internet: Email, Collaborative Computing and Social Networking; The Internet: E-Commerce, IT Security and other issues, Project Week, Review Week.

Lab. Work:


Objectives:

To develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.
Course Outline:

1. Historical Perspective: a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah; b. Factors leading to Muslim separatism; c. People and Land (i. Indus Civilization, ii. Muslim advent); Location and geo-physical features.
3. Contemporary Pakistan: Economic institutions and issues; Society and social structure; Ethnicity; Foreign policy of Pakistan and challenges; Futuristic outlook of Pakistan.

Recommended Books:


Econ-402 FUNDAMENTAL OF ECONOMICS 2+1=3 Crh

Objectives:

Definition of Economics and basic terms. What are key Scarce Economics Resources? Opportunity Cost, Sacrifice, Economics Principles and Theories, Consumers (Demanders) and Producers (Suppliers)? Why is Economics

Lab. Work:

**Not required.**

Recommended Books:

Objectives:


Objectives:

Broadening the scope of harvesting of marine resources. Technological advancement in developing conventional and non-conventional marine products. Sustainable utilization and development of marine resources.

Course Outline:

Identification of living and non-living resources on the coast, seabed and offshore areas. Aggregates, sea salt. Gas hydrates, commercially important seabed minerals. Renewable energy from waves, tides, currents. Sustainable development of coastal and offshore resources. Living resources i.e. sponges, crustacean, molluscan, echinoderms, Fish, turtles, mammals, seaweeds and Mangroves. Plankton fisheries and pearl fisheries, exploration of local potential commercial species with reference to regional fisheries.

Lab. Work:
Identify coastal resources along the Pakistan Coast. Introduction of GIS techniques to develop and highlight coastal resources.

Recommended Books:


OCEANOGRAPHIC INSTRUMENTS AND METHODS
2+1=3 Crh

Basic Definitions & Concepts; Hardware: Computer Systems & Components, Uses, importance and future needs. Exploring Windows: work place: desktop components and customizing them exploring parts of a window, menu and dialog boxes, multitasking, and shutting down windows. Recommended Books: To educate students on the basics of economics with a focus on application and principles in practical scenarios and everyday activities. Basic economics concepts, applications, and principles; budgeting for success; and wealth building. Course Outline:

Recommended Books:

Students will learn about the microbial world in seas and oceans, their role in the environment, importance in the marine food web.
Outline: Introduction to marine microbiology (microbial environment, biological organization and evolution, importance of microbes and their sizes, chemical & physical factors influencing microbial distribution and processes, marine microbial habitat); Methods in microbiology, physiological processes of Cell; Eukaryotic microbes (nanoplanktonic flagellates, dinoflagellates, ciliates, diatom, coccolithophorids, radiolarians, foraminifera, fungi), Prokaryotic microbes [bacteria and cyanobacteria (Blue-green Algae)], marine Archaea), Role of microbes in oceanic processes (primary productivity, carbon and nitrogen cycling), marine microbial loop, Eutrophication, Symbiotic Association,

Objectives:

Introduction to the principles of the instruments, Brief account of: time and position measurements [clocks, time signals, ground- and satellite-based navigation (GPS/ RS/ GIS), attitude/ motion sensors], data logging (analog and digital recorders, telemetry, memory and recording, water properties measurements (temperature, conductivity, oxygen, optical properties, tracers and dyes), Secchi Disk, Rosette (Nansen/ Niskin Bottle, XBT), seabed sampling (grabs, corers, ROVS, underwater cameras), current measurements [mechanical, acoustic, electromagnetic, optical, radar (Ecosounder, waverider buoy, drifters), pressure and sea level measurements, mechanical technology (cables, winches, buoys, anchors)], Scuba Diving and Snorkelling gears.

Lab. Work:

Plotting and understanding basic Oceanographic parameters and sampling techniques, instruments and methods, Tests of different parameters. Demonstration of tidal pattern. Short field deployment of available instrument, and analyzing the resulting data, field visits.

Recommended Books:

2. Baker, D.J., Ocean instruments and experiment design in Evolution of physical oceanography.
FIFTH SEMESTER

MS-501 APPLICATION OF REMOTE SENSING AND GIS 3 Crh

Objectives:

This course is designed to introduce principles, concepts and applications of Geographic Information Systems (GIS) and Remote Sensing (RS): a decision support tool for planners and managers of spatial information and to obtain information on the earth from decimetre level to km level locally and globally.

Introduction to Geographical Information System, Data Types (Spatial/Aspatial), Data Models and Structures (Raster/Vector), Data Sources and Capturing Techniques, Displaying and Manipulating spatial information, Vector Data Preparation (Digitization and Spatial Data Editing), GPS Survey, Introduction to the concept of RS, Electromagnetic Spectrum, Atmospheric Interaction, Technology of Remote Sensing (Orbits, Satellites, Sensors and Platforms), Applications of Remote Sensing, Satellite Image Processing Cycle, Image Enhancement, Data Fusion and Mosaicking, Information Extraction (Classification and Vectorization).

Lab. Work:

Introduction to ArcGIS, Exploring GIS Dataset in ArcCatalog, Working on vector data in ArcGIS (Scanning, Digitization and Editing), Integrating GPS data in GIS Environment, Applications of GIS, ERDAS Imagine - Environment, Noise Corrections, Geometric Corrections, Radiometric Corrections.

Recommended Books:

Objectives:
The purpose of the course is to give the students a comprehension of hydrography along with fundamentals of hydrographic surveying methods and measurement principles with practical demonstration to enable students to participate effectively in various hydrographic surveying tasks.

Course Outline:
Definition of Hydrography; Importance of hydrographic surveying; Contributions of hydrography to Maritime Activities including support for Port Management, coastal engineering and offshore construction; Economic benefits of hydrography; Principles of Hydrographic Surveying; Geodesy (Ellipsoid, Geoid, Projections, Datum transformation, vertical datums and reference planes); Surveying equipment and their calibrations; Positioning (Basic knowledge, GPS, DGPS, RTK, Underwater positioning); Bathymetry (General, Single-beam, Multi-beam); Data acquisition and Processing using Single and Multi-beam echo-sounding systems and other sensors such as Side Scan Sonar, Sub-bottom Profilers, Sound velocity meter and Land Surveyor’s equipment with its accuracies; DGPS Accuracy, Error detection, Statistics; Tides (Theory, Observations, Predictions and uses of Tidal information); Quality assurance; Project Management; Hydrographic Data management; Nautical Charting; National/ Port Hydrographic organizations with roles & responsibilities and National Hydrographic Service obligations under the SOLAS Convention.

Lab.
OJTs on hydrographic equipment; Practical demonstrations and visit to National/ Port Hydrographic setups.

Recommended Books:


MS-505 MARINE BIODIVERSITY 2+1=3 Crh

Objectives:

2. Miller, B.T., The Living Oceans. Island Press, USA.

MS-507 COASTAL PROCESSES 2+1=3 Crh

Objectives:


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Objectives:

Concept development of Marine Chemistry.

Course Outline:

General introduction and history, Chemical composition of seawater, Physico-chemical properties of seawater (Structure, Chlorinity, Salinity, Refractive index, Electrical conductivity, Density, Temperature), Dissolved gases Solubility, distribution, Atmospheric exchange, CO₂ equilibria), Micronutrients (Composition, Distribution, Cycles), Minor and Major elements, Dissolved organic particulates, Radioisotopes, Primary productivity in relation to chemical constituents. Basic marine sedimentary constituents, inorganic deep-sea sediment, pelagic and non-pelagic biogenous and chemical composition of sediments.

Lab. Work:

Seawater and sediment collection techniques, Sample collection and preservation, Salinity measurement, Analysis of seawater for dissolved gasses, nutrients and chlorophyll, Field visit.

Recommended Books:

Objectives:

To give detail overview of the structure, evolution and geological processes of the ocean basin and continental margin. This course will enable the students to fully understand the marine environment, what dynamic processes shape the surface of the earth under the ocean surface, sedimentation processes, and Sediment distribution on seafloor.

Course Outline:


Lab. Work:

Specific exercises/ Field Assignments.

Recommended Books:

Objectives:

Climate change is one of the most controversial issues of the 21st century. This introductory course presents Earth’s climate system and explores the science and related issues of global climate change.

Course Outline:

Fundamental principles of climatology; Earth-Sun relationship: earth's radiation balance, latitudinal and seasonal variation of insolation, temperature, humidity and precipitation rate in Pakistan with special reference to seasonal distribution and variations of temperature and wind; air masses notably monsoons' and jet streams, tropical cyclones, and cloud formation, classification of climates. Hydrological cycle and water balance. Climate change; greenhouse warming, stratospheric ozone depletion. Paleoclimatology. Principal seasons of subcontinent, winter season; western disturbances, anticyclones and associated weather, fog, hail, thunderstorms, cold waves, subtropical westerly jet stream, Monsoon season; cyclonic storms, dust storm, heat waves, southwest monsoon season, north-east monsoon; active and break cycle, monsoon depressions, rainfall and its variability, drought, aridity, cyclonic storms in Arabian sea.

Lab. Work:

Not Required

Recommended Books:

INTRODUCTION TO AQUACULTURE

Objectives:

To develop the basic learning and practical knowledge in the field of aquaculture.

Course Outline:

Introduction to Aquaculture, History and scope of aquaculture. Site and species selection criteria. Sources of seed. Systems of aquaculture (pond, cage, pen and race-ways culture) their planning, construction, and management. Types of Aquaculture such as extensive, semi-extensive, intensive, mono, poly and integrated. Water quality parameters (abiotic: temperature, light, salinity, pH, turbidity, etc.) and Biotic parameters (Plankton, insects, aquatic vegetation, etc.) and their effect on fish production, food and feeding of fish. Artificial and natural fish food, feed formula and ingredients, Fish diseases and their control. Production harvest, preservation, processing and transportation. Fish marketing and economics.

Lab. Work:

Water quality assessment and management. Morphological characters of typical fish, morphometric, species identification, fin formula, etc., key to identification of commercial shrimp and fishes. Visit to fish farm, visit to fish market. Formulation and preparation of artificial feed in laboratory. Estimation of feed conversion efficiency Estimation of specific growth rate from data obtained. Fish diseases (bacterial, fungal and parasitic) samples study and slides.

Recommended Books:
To understand the structure and function of marine biodiversity components from genes to habitats and develop skills to carry out impact assessment and conservation.

Course Outline:
The structure and functioning of Marine Biodiversity (genus specific habitats).

Work:
Systematic studies of major biological taxa, field trips on biodiversity in situ, use of biodiversity indices.

Recommended Books:
10. Wedemeyer, G., Fish Hatchery and Management.

MS-506 PHYSICAL OCEANOGRAPHY 2+1=3 Crh

Objectives:

This course is designed to introduce students to the important physical processes in the oceans in such a way that they will understand both the conceptual physical principles and at the larger scale how these fit into the earth as a system.

Course Outline:
This course is designed to introduce students to the important physical processes in the oceans in such a way that they will understand both the conceptual physical principles and at the larger scale how these fit into the earth as a system.

Course Outline:
Ocean dimensions, shape and bottom material, Physical Properties of Seawater, Chlorinity, salinity, thermal properties, T-S diagram, density, pressure, optical properties, transmission of sound, Equation of state of seawater, General ocean circulation, dynamics of circulation, Ekman flow, Upwelling, convergence, Western and Eastern boundary currents, thermohaline circulation, formation of water masses; Ocean Waves and
Tides, Coastal Processes, Long shore currents, Rip currents, Hydraulic regime, oceanography of Arabian sea.

Lab. Work:

Plotting and understanding basic Oceanographic parameters and sampling techniques, instruments and methods, Tests of different parameters. Demonstration of tidal pattern. T-S diagram. Data handling and processing using dedicated software.

Recommended Books:

5. Severdrup, Johnson and Fleming, The Ocean. Study the effects of seawater movement on the coastal sediments, role of beach sediments in the protection of coasts, anthropogenic activities that alter the beach profile. Waves, tides, coastal currents. Work: Microscopic examination of beach sediments, identification of Biogenic ooze. Recommended Books:
Objectives:

To introduce basic concepts of oceanography, biodiversity, ecology and evolution as they pertain to marine coastal environments. To learn through theoretical and practical exercises how environmental and biological factors interact to sustain near-shore ecosystems. To acquire field skills to study marine near-shore environments. To improve discussion, analytical, presentation and writing skills.

Course Outline:

Biodiversity of different shore types such as rocky, sandy, muddy, rocky-sandy, rocky-muddy and sandy-muddy shores etc. Seaweeds and Mangroves. Interaction of biological factors to sustain near-shore ecosystems. Coral reef systems, physiological and behavioural adaptations that enable organisms to live in a particular environment. Basic ecological principles, marine conservation, metapopulations dynamics, adaptation to climate change, and conservation genetics.

Lab. Work:

Field trips of different shore types.

Recommended Books:

Objectives:

The course has been designed to provide background for and exposure to current research in marine geochemistry to understand the role of physical, chemical, biological processes in controlling chemical distribution in the marine environment.

Course Outline:


Lab. Work:


Recommended Books:


Work:
MS-512 RESEARCH METHODOLOGY 3 Crh

Objectives:

To prepare students have better understanding of different research methods and analyse data.

Course Outline:

Research design, Personal Statement, Research Proposal, Research Question or Problem Statement, Samples and Sampling techniques, Qualitative and quantitative methods, Research Techniques (Structured interviews, questionnaires, interpretive biographies, focus groups, participant observation), Modes of analysis (Thematic and content analysis) results and its interpretations, References and references styles, Research ethics.

Lab Work:

Not required.

Recommended Books:

SEVENTH AND EIGHTH SEMESTER

MAJOR ELECTIVE MODULES

Module I: Biological Oceanography and Conservation (BOC)

MS-BOC-601  AQUATIC PATHOLOGY AND PESTS  2+1=3 Crh

Objectives:

To study about symptom, causes and cure of diseases of aquatic organisms.

Course Outline:


Lab. Work:


Recommended Books:

4. Nair, R.R., Encyclopaedia of Fish Disease.
6. Roberts R.J., Fish Pathology.
7. Schaperclaus, Fish Diseases.
Objectives:

The students having the knowledge of Biology and Physics would learn biophysical processes during this course.

Course Outline:

Nature and scope of biophysics; Molecular Structure of Biological Systems; Chemical binding, energies and bonds; Energy transfer and transformation in photosynthesis and biological membranes; Dynamics of biological systems; Fundamental concepts of thermodynamics, aqueous and ionic equilibrium of living cells; Other biotransport processes; Long and short distance transports; Viscoelastic properties of biomaterials. The biomechanics of human body, blood circulation, swimming and flying; Physical factors of the environment; Biophysics of hearing, infra and ultrasounds; Biomagnetism: Magnetic effects on humans and other organisms; Ionizing radiations; Radiobiological reactions; Vision, biosensing and biomechanics; Models approaches for propagation, ecological interactions, growth, differentiation evolution and neural process.

Lab. Work:


Recommended Books:

Objectives:

To understand evolution at cellular and molecular level.

Course Outline:

Evolutionary theory and genetical basis of evolution, fundamental principles of population genetics and comparative genomics. Cell structure and function at molecular level, Structure and function of macro-molecules, nucleic acid and information storage, translation into RNA and protein., Control of gene expression, Cell signalling. Classical population genetics, quantitative genetics, molecular evolution, human evolution, phylogenomics and speciation.

Lab. Work:

Students will be assigned problem sets during lectures as well as computational resources, tools be introduced during labs.

Recommended Books:

Objectives:

To understand the chemical and physiological behaviour of cell.

Course Outline:

Structure, evolution and simple biochemistry of cell, Cell physiology, Special topics in aquatic biochemistry (bioluminescence, osmoregulation, tolerance to extreme environments). Organic chemistry and biochemistry including proteins, DNA, RNA, and chemical origins of life. Nature of chemical and biochemical discoveries.

Lab. Work:


Recommended Books:

Objectives:

This course would focus on the concepts and theories in ecology that have the greatest potential for conserving biological diversity.

Course Outline:


Lab. Work:

Case studies: students are required to select a site or community, collect data, and design a management plan for that particular site or community.

Recommended Books:

Objectives:

The aim of this course is to provide thorough knowledge about the diversity of invertebrates and vertebrates like birds, fish, amphibians, reptiles and mammals, as well as understanding of how knowledge about these organisms can be applied in conservation biology and environmental work.

Course Outline:

Animal groups of invertebrates and vertebrates i.e. fish, amphibians/ reptiles, mammals and birds. Identification of species comprises appearance and in certain cases also sounds, tracks and other signs. Use of identification literature. Adaptations to the environment, animal communities, reproduction and dissemination strategies, as well as inventory methods.

Lab. Work:

Collection, preservation and identification of marine organisms.

Recommended Books:

Objectives:

This course provides general information on dangerous marine life that may be encountered during marine operations. This course is designed to teach students how to avoid these organisms to minimize the chance of injury and how to apply basic first aid specific to the injuries caused by each dangerous plant or animal.

Course Outline:

Predatory (Sharks, Killer Whales, Barracuda, Moray Eels, Sea Lions), Venomous Fish (Excluding Stonefish, Zebrafish, Scorpionfish; and Highly Toxic Fish (Stonefish, Zebrafish, Scorpionfish), Stingrays, Coelenterates, Octopuses, Segmented Worms (Annelida; e.g. Bloodworm, Bristleworm), Cone Shells, Sea Snakes and Poisonous marine animals. Ciguatera Fish Poisoning, Scombroid Fish Poisoning, Puffer (Fugu) Fish Poisoning, Paralytic Shellfish Poisoning (PSP; Red Tide), Sea Cucumbers and Parasitic Infestation. First Aid and Treatment.

Lab. Work:

Not required.

Recommended Books:

6. Diving and Subaquatic Medicine, Diving Medical Centre, Masman N.S.W., Australia; 1981, Second edition; C. Edmonds, C. Lowry and C. Pennefather.
7. Edmonds, C., *Dangerous Marine Creatures*, Reed Book Ptg., Ltd., 2 Aquatic Drive, French’s Forest, NSW 20806 Australia.
Objectives:

The primary goals of this course are to learn about the cellular and protein components of the mammalian immune system, and to gain an understanding of how they function.

Course Outline:


Lab. Work:

Specific case studies and assignments etc.

Recommended Books:

2. Janeway’s Immunobiology 8e, 2011, Murphy, Garland Publishing.
Objectives:

The aim of this course is to provide thorough knowledge about the diversity of invertebrates and their biology. To survey the diversity of the invertebrate animal phyla by comparing the body-plans, life histories, and ecologies of representative species. To understand some of the behavioural habits, such as feeding behaviour, migration, locomotion, and reproduction of each group.

Course Outline:

Introduction to marine invertebrate, taxonomy, morphology and ecology of invertebrate animals. Review and diversity of all animal phyla to at least the Linnaean Class level (except for vertebrates). Diversity of the invertebrates. Reproduction and Development, Evolution of Developmental Patterns, Porifera, Echinoderms, Mollusks, Arthropods, Crustaceans: Shrimp, Prawns, Lobsters and Crayfish. Identification, anatomy and ecological relationships. Commercially important Mollusks and crustaceans of Pakistan.

Lab. Work:

To identify invertebrate taxa, recognize common local species, identify common and unknown species, have an understanding of the ecological relationships of the local species, be able to collect and properly preserve organisms, be competent in the use of microscopes for dissection and identification. Identification of intertidal organisms: a) Rocky shore-Patella, Chiton, Fissurella, Mytilus species, Pernaviridis, Cardium, Balanus, Gorgonids, Littorina and Corals; b) Sandy shore: Solen, Umbonium, Oliva, Pea crab, Fiddler crab, Molluscan shells, Star fish and Balanoglossus; c) Muddy shore: Lingula, Chaetopterus, Arenicola, Tubiculus worm and Mud skipper.

Recommended Books:

MS-BOC-610  PHYSIOLOGY OF MARINE ORGANISMS  2+1=3 Crh

Objectives:

Comparative study of anatomical and taxonomical features and vital functions of major invertebrates and vertebrates, Life histories, Defense mechanism and predation, Food capture and choices, reproduction, respiration, osmoregulation and excretion, locomotion. Trophic relationship, ecology and adaptation.

Course Outline:


Lab. Work:

Dissection of type specimens of marine animals (fish, crab, shrimp, polychaetes), study different systems, gut contents studies.

Recommended Books:

Objectives:

To introduce students tiny suspended marine organisms, their biology and importance in productivity of marine environment.

Course Outline:


Lab. Work:

Collection and identification of common marine and estuarine phytoplankton and zooplankton. Methods of collection, preservation and analysis of plankton. Quantification of phytoplankton, Culture, and Cultivation.

Recommended Books:

Objectives:

To understand behaviour and biology of marine organisms with respect to their conservation.

Course Outline:

Study of different groups of animals and plants using live, skeletal and fossil casts (birds, mammals, turtles, other target groups), Behaviour of target groups of animals and plants, Threats and issues of target groups and Conservation strategies.

Lab. Work:

Visits to conservation sites/protected areas. Study of fossil specimen and skeletal materials Assignment/case study.

Recommended Books:

Objectives:

To recognize marine algae from Pakistani waters. To understand the identifying characteristics of major classes and families of marine algae. To classify individual marine flowering plants by class, order, family, genus and species.

Course Outline:


Lab. Work:

Collection and identification of common marine and estuarine microalgae, macroalgae and halophytes. Marine and estuarine submerged aquatic vascular plants (Mangroves morphology, occurrence, and important morphological measurements.

Recommended Books:

Objectives:

To educate students about potential of agriculture in coastal areas or saline habitats.

Course Outline:


Lab. Work:


Recommended Books:

Objectives:

Understanding of major food safety hazards and control, handling, storage and shelf-life of fishery product, International laws regarding food safety.

Course Outline:

Food safety hazards using HACCP principles, developing HACCP regulations, Hazard Analysis, Critical Control Point (CCP) determination, monitoring CCP and verification procedures, sanitation control procedures, biological hazards- microorganisms/ pathogens, (yeasts, moulds, bacteria especially spore forming, viruses, non spore forming protozoa, food spoilage, parasites- worms, protozoans and food additives. Food processing technologies. ISO 9001-2000 and ISO-17025.

Lab. Work:

Visit to fish harbour and fish processing industry. Report writing on the major fish processing issues and its control.

Recommended Books:

Objectives:

The purpose of this course is designed to expose the student to the skills, enjoyment and equipment necessary to explore the underwater world. To experience the wonders of the undersea life using SCUBA equipment. It provides general guidance applicable to maintaining all diving equipment and diving systems and prepares student for certification as a certified Open Water Diver.

Course Outline:


Lab. Work:

Practical training of skin and SCUBA diving to demonstrate proper use of the mask, snorkel and fins, basic skin diving techniques, a safe and successful descent and ascent and proper procedure for handling a diving accident.

Recommended Books:


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**MS-BOC-617**  
**SYSTEMATIC STUDIES OF MARINE ORGANISMS**  
2+1=3 Crh

**Objectives:**

To understand the historical background of taxonomy and classification system.  
To learn about different species concepts. To identify and differentiate among species.

**Course Outline:**

Systematics of living marine organisms. introduction, history and role of taxonomy in biology, binominal nomenclature, microtaxonomy, phenon, taxon, species concepts (typological concept, nominalist concept, biological concept, evolutionary concept), non-dimensional species concept; Multidimensional species concept; Cohesion species concept, polytypic species, subspecies, super species, sibling species, Macro-taxonomy; different kinds of taxonomic characters; Taxonomic collection and identification; definitions of Synonym, Homonym, evolutionary concepts.

**Lab. Work:**

Study of preserved invertebrate species and their classification up to class level. Collection, preservation and identification of common species with the help of keys.

**Recommended Books:**

Objectives:

To introduce students the diversity of vertebrates with emphasis on marine animals and their phylogenetic relationships. To demonstrate interrelationships between vertebrate structures, function, physiology and ecology. To learn concepts of classification and apply them to the identification of marine vertebrates. Upon completion students should be able to identify marine vertebrates and demonstrate an understanding as how marine vertebrates used to survive in the ocean.

Course Outline:

To study classification and habitats of marine vertebrate’s morphology, physiology, anatomy ecology and evolution of vertebrates. Vertebrate ancestry, behaviour and classification of marine fishes, reptiles, birds and mammals. Identification, feeding behaviour, reproduction, migration and other characteristics of marine vertebrates. Taxonomy of commercially important vertebrates of Pakistan, Benthic, demersal, pelagic and mesopelagic fishes. Reproduction and life-history of selected marine vertebrates. Age determination techniques in fish. Fish processing techniques.

Lab. Work:

Collection of vertebrates, preservation, staining, mounting, skeletonization, skinning and stuffing of fishes (Taxidermy), preparation of drawings, photography of large specimens. Identification of species/genera, preparation of collection record. Sampling design and methods for field collection. Identification of commercially important fish, in the field and laboratory. Gonad maturation index, procedure for counting of eggs of fish larvae. To identifying characteristics of major classes and families of marine vertebrates. To classify individual vertebrates by class,
order, family, Genus and species sampling on field trip. Collection analysis and examination of organisms in the field and laboratory.

Recommended Books:


**Module II: Chemical and Environmental Oceanography (CEO)**

MS-CEO-601 BIOREMEDICATION 2+1=3 Crh

Objectives:

To use microorganisms and plants for the remediation of contaminated soil, sludge and groundwater.

Course Outline:

What is bioremediation? Managing a bioremediation project, Microbial systems of bioremediation, Site characterization for bioremediation, Treatability Studies, Bioremediation processes, Phytoremediation of organic, metals and inorganic contaminants.

Lab. Work:

Field trips of the wetlands. Discussion with the pytoremediation experts at the Garden on the design and operation of the wastewater wetlands.

Recommended Books:

Objectives:

An environmental impact assessment (EIA) is an assessment of the possible impact - positive or negative - that a proposed project may have on the environment, consisting of the natural, social and economic aspects with special focus on coastal installations.

Course Outline:


Lab. Work:

Small projects may be given.

Recommended Books:

Objectives:

The oceans are in interactive contact with the atmosphere, biosphere and lithosphere and virtually all elements pass through the ocean at some point in their cycles. In this course the first-order processes that take place within the sea and affect its chemistry will be studied. What controls the distribution of chemical species in seawater and sediments? How long do different elements spend, on average, in the ocean? How do marine chemical processes interact with the biological, geological, and physical processes in the oceans? How can the chemistry of the oceans affect the future of planet Earth?

Course Outline:

Physical, chemical, and biological processes governing the chemical composition of sea water in estuarine, coastal and marine environment. Nutrient and carbon fluxes, interstitial water chemistry, sea surface layer chemistry, air-sea inter-action, analytical marine chemistry.

Lab. Work:

Coastal and deep sea water sampling techniques and protocols; Extraction of water from marine and deep sea sediments, Preservation of water samples at sea organic/ in-organic chemical/Analytical techniques for sample analyses.

Recommended Books:

Objectives:

Marine biogeochemistry focuses on the role of the marine system in the global cycles of climatically active trace gases, including sulphur gases, nitrous oxide and methane, parameterisation of air-sea gas exchange and the understanding of large scale oceanographic processes through the use of purposefully released tracers, the role of the bacterioneuston in air-sea trace gas exchange and the reactivity and photochemistry of chromophoric dissolved organic matter in freshwater and marine environments and implications for global biogeochemistry.

Course Outline:


Lab. Work:

Estimation of elemental concentration in sediment samples, primary productivity of different habitats and composition of organic matter.

Recommended Books:

Objectives:


Course Outline:

Introduction to ecotoxicology, major environmental contaminants, bioaccumulation factors influencing bioaccumulations, uptake, biotransformation, de-toxification, elimination and accumulation, transfer to various tropic level and their impact, molecular effects on biomass, acute and chronic lethal effects to marine organisms and ecosystems.

Lab. Work:

Study of different ecosystems.

Recommended Books:


Objectives:

To give students concepts of marine environment those culminate with the prediction of marine meteorology.

Course Outline:

State of the atmosphere, Thermodynamics of dry air, moist air: Isobaric processes for moist air, Vertical stability of the atmosphere, Solar Radiation: Characteristics of the sun; Nature of solar radiation; Definitions and concepts in radiation; Transfer of radiation through a medium; Terrestrial radiation; Characteristics of terrestrial radiation; Absorption of terrestrial radiation; Transmission of terrestrial radiation through the atmosphere; Simpson’s computation of terrestrial radiation transfer; Elsasser’s radiation chart; Radiative cooling or heating of the atmosphere; The mean heat balance of the earth - atmosphere system; The atmospheric green house effect.

Lab. Work:

To demonstrate how can the Marine Environment be altered by the changes in the atmosphere?

Recommended Books:

Objectives:

The course will focus on identification of natural product chemistry of marine organisms (Plants and Animals) and their uses. Basic information regarding biosynthesis and bioassay screening to be provided.

Course Outline:


Lab. Work:

Basic principles of techniques used for biosynthesis and bioassay screening for marine natural products.

Recommended Books:

Objectives:

To understand pollution, its sources and implication with the biotic and abiotic environment.

Course Outline:

Introduction to marine pollution, chronic and acute inorganic and organic marine pollutants. Causes, effects and impacts on marine environment and humans. Health of the oceans, ocean disposal (marine outfalls, shipboard wastes, dumping of sludge, disposal of dredge spoil, radioactive wastes) and its impact. Marine pollution control and mitigation measurements; oil spills contingency plan and combating techniques.

Lab Work:

Seawater, sediment and marine organism analysis for different marine pollutants.

Recommended Books:

Objectives:

Broadly, course is designed to learn collection and analysis of scientific data with respect to natural hazards. To study the hazards, its history, trends and definitions. How and why places are hazardous, including the human geographic processes that put people at risk. Understanding of human nature and responses to disasters, and how science can be applied in the face of such disturbance.

Course Outline:


Lab. Work:

Specific assignments may be given.

Recommended Books:

2. Ebert, C.H., Disasters, An Analysis of Natural and Human-induced Hazards.
3. Hyndman, D. and Hyndman, D., *Natural Hazards and Disasters*.
Objectives:

To obtain an in-depth understanding of why and how chemical reactions occur, which in turn may enable us to accurately design reactions leading to novel molecules of the future? To obtain a vision of matter-energy relationship in physical and chemical systems and understand transformations at the molecular level.

Course Outline:


Lab. Work:

**Practical related to thermodynamics, mixtures and solutions. Assignments may be given to develop a marine product.**

Recommended Books:

Objectives:

This course examines the nature of point and non-point sources of surface and ground water pollution and examines the framework controlling water quality management activities.

Course Outline:

Water chemistry, water microbiology, water quality and pollution, drinking water treatment, wastewater collection and treatment, storm water management, best management practices (BMPs) and treatment, groundwater management, industrial wastewater treatment.

Lab. Work:

Laboratory chemical analysis of different types of waters.

Recommended Books:

Module III: Fisheries and Aquaculture (FA)

**MS-FA-601 ADVANCED AQUACULTURE** 2+1=3 Crh

Objectives:

This course will enable to understand different culture systems, their designs and operations. Understanding the requirement of each system, its feasibility will help develop a feasible culture system in a given area.

Course Outline:

Introduction to development of aquaculture systems: design, construction and operation, feasibility and economics of marine invertebrates and vertebrates. Recirculating water system: advantages and disadvantages, types and economic considerations.

Types of culture systems: Pond culture: Scope and objectives, types of ponds, design and construction, soil properties, water budget, fry rearing techniques, production rates, Harvesting and economic aspects. Cage and Pen culture: scope and objectives, types of ponds and cages, design and construction, selection of suitable site, cultivable species, farming operation and management. Brood stock conditioning, spawning, rearing and harvesting.

Seaweed culture: Scope and objectives, culturing practices, site selection criteria, cultivable species, and procurement of seed, farming operation and management.

Lab Work:

Assignment/case study on aquaculture systems, visits to aquaculture facilities/ hatcheries.

Recommended Books:

2. Bardach, J.E., Sustainable Aquaculture.
Objectives:

This course will enable students understand different environment management systems required for aquaculture.

Course Outline:


Lab Work:

Assignment/ case study (Market analysis, environmental impact, legal framework etc.).

Recommended Books:

3. Wedemeyer, G., Fish Hatchery and Management.
Objectives:

This course will enable students understand different health management measures required for aquaculture.

Course Outline:


Disease issue in aquaculture: principal pathogens, effects. Diagnosis of pathogens: clinical, post-mortem and histopathological examinations, serology. Control: Non-infectious diseases, addition of chemicals to water, addition of chemicals to feed, medication directly to fish, antibiotics and probiotics. Socio-economic effects of diseases of fish and shell-fish.

Lab. Work:

Identification and microscopic examination of bacteria and fungus causing disease. Identification and microscopic examination of common parasites causing disease. Examination of Pathological type specimen and histological slides.

Recommended Books:

Objectives:

This course will enable students understand different nutritional requirements for aquaculture practices.

Course Outline:


Lab. Work:

Nutritional evaluation of feed ingredients (total protein, lipids, carbohydrates and gross energy). Feed formulation: calculation for protein and energy levels in manufactured feed. Live feed: Microalgal and zooplankton culture (media preparation, maintenance and examination).

Recommended Books:

Objectives:

To understand economic perspective of fisheries, maximum economic yield, fisheries efficiency, failure and control.

Course Outline:

Economic perspective of fisheries management, Economics of fish, Maximum Economic Yield (MEY), Bio-economic modelling and MEY targets, Data for economic analysis for commercial fisheries, Measurement and analysis of efficiencies in fisheries, Understanding and measuring capacity in fisheries, measuring productivity and decomposing profits in fisheries, Economic insight, problems, policy choices, challenges of uncertainty, Adaptive measurement, Fisheries failure and control.

Lab. Work:

Analysis of maximum economic yield. Analysis of fisheries efficiency.

Recommended Books:

Objectives:

To understand fish and shell-fish resources, conservation and management.

Course Outline:

Coastal, demersal and pelagic resources, Shell-fish resources, commercially important species, Overexploitation, Conservation of resources, Marine-protected areas, Environmental issues, Management issues and control, international laws related to fisheries practice and management.

Lab. Work:

Study of important coastal, demersal and pelagic fish and shell-fish resources. Case study of overexploitation. Case study of conservation strategies.

Recommended Books:

Objectives:

Understanding of fishing gears and method, fishing policies, fish population assessment and statistical methods.

Course Outline:

Fishing gears and methods, Illegal fishing gears, Analysis of fish population data, Methods for estimating fish population parameters (age, growth, recruitment, mortality), Use of computer modelling in fisheries, Fisheries statistical data analysis.

Lab. Work:


Recommended Books:

Objectives:

To study about growth, mortality and exploitation rate.

Course Outline:


Lab. Work:


Recommended Books:

Objectives:

To understand breeding, taxonomy and morphology of marine species and water quality management.

Course Outline:

Breeding criteria of marine species: taxonomy and morphology, life history, food and feeding habits, reproductive development, fecundity and spawning, Hatchery design: species consideration, site selection and hatchery size, Water quality management, Hatchery facilities and equipment. Hatchery operations: brood stock collection and rearing, spawning and fertilization, incubation and hatching, harvest and transport, plankton/microalgal culture.

Lab. Work:

Detailed study of established hatcheries, Taxonomy and biology of commercially important species (fish, shrimp, crab, bivalves), Study of larval developmental stages (slide preparation and microscopic examination).

Recommended Books:

1. Beveridse, M., Cage Aquaculture.
8. Wedemeyer, G., Fish Hatchery and Management.
Objectives:

To recognize all major taxonomic groups of fishes and systematics of common fishes. Understanding of basic anatomy and physiology, evolution and zoogeography of major groups of fishes of fishes. Understanding of current issues concerning conservation and fisheries management.

Course Outline:


Lab. Work:

Identification of some common marine fishes. Study of general anatomy and systems (dissection of some representative fishes).

Recommended Books:

Objectives:
To develop understanding of fisheries resources and management.

Course Outline:
History of fisheries, Aquatic resources, Fishing Gears and fishing techniques, Population dynamics and modeling, Fisheries data analysis, Threats to fishing and factors leading to unsustainable fishing, Illegal, unregulated and unreported (IUU) fishing, Fisheries perspective of Pakistan, Conservation and sustainable management of Fisheries resources. Post-harvest management. Seafood processing and value addition. National and International Legal framework and policies.

Lab. Work:
Study of fishing gears. Sampling design and methods of field collection. Identification of commercially important finfish and shellfish species. Assessment of maturation and spawning of commercially important species. Regular field visits of fish landing sites.

Recommended Books:

MS-FA - 612: Seafood Handling, Processing and Safety
(For description please refer to Module I: MS-BOC - 615)
Module IV: Geological Oceanography (GO)

MS-GO-601

COASTAL AND MARINE
SEDIMENTOLOGY

2+1=3 Crh

Objectives:

This course is designed to acquire the knowledge about various types of sedimentary environment and processes. This will help the students to understand the dynamics and natural processes involved in the coastal and marine system.

Course Outline:


Lab. Work:

Grain size analysis of sediments and sedimentary rocks. Megasscopic and microscopic study of sedimentary rocks. Separation and identification of heavy minerals. Study of sedimentary structures.

Recommended Books:

Objectives:

The primary goal is to provide background and exposure to current geological knowledge of Arabian Sea. To acquaint students with Arabian Sea geology and its resources prospects. This will pave the way for better exploration and management of offshore environment.

Course Outline:


Lab. Work:

Selected Exercises based on national and international Geological research Cruises data of Arabian sea.

Recommended Books:


Objectives:

The primary goal is to provide background and exposure to current hydrogeological knowledge of Earth. This will pave the way for better understanding of underground environment.

Course Outline:

Introduction, Hydrogeologic cycle, water budgets, Aquifer properties, Aquifer properties, continued, Groundwater flow, Flow of groundwater to wells, Aquifer tests and monitoring well installation, Regional groundwater flow, case studies, Groundwater-surface water interactions, case studies, Geochemistry of groundwater, Groundwater pollution (e.g., nitrate, heavy metals, organics), Contaminant transport, case studies, Geochemical tracers, stable isotopes, case studies.

Lab. Work:

There will be at least 1 field trip (one or two days) to a nearby groundwater contamination site.

Recommended Books:

Objectives:

This a wide spectrum of marine geophysical exploration methods have been developed in last two decades. The range of application extends from marine resource exploration to scientific investigations in the deep ocean. Introduction to Marine Geophysics course is designed to provides students knowledge of basic field skills in applied marine geophysics. The aim is to introduce the basic physical principles of off shore exploration and practical application to the geophysical techniques. At undergraduate level marine science students will highly benefit from understanding the role of geophysics particularly in hydrocarbon and mineral exploration.

Course Outline:


Lab. Work:

Analysis and interpretation of geophysical data, Seismic images interpretation and understanding of subsurface geological features.

Recommended Books:

MS-GO-605 MARINE NON-LIVING RESOURCES 2+1=3 Crh

Objectives:

This course will enable students to have an idea regarding non-living marine resources of Pakistan and possibility of exploiting them.

Course Outline:


Lab. Work:

Specified assignments.

Recommended Books:

Objectives:

This course is designed to acquire the knowledge about the various types of plate boundaries, their kinematics and dynamics. This will help the students to understand the sea floor spreading and geological histories of the ocean basin.

Course Outline:


Lab. Work:

Specified assignments/projects/Field visits with respect to fossil record collection.

Recommended Books:

Objectives:

This course is intended for advanced undergraduate and graduate students who are interested in learning about the history of the oceans and earth’s climate. Students will acquire a broad spectrum of geological approaches, including paleontology, geochemistry and stratigraphy, to interpret the history of oceans and how paleoclimate studies help to learn more about the workings of the climate system.

Course Outline:


Lab. Work:

Paleoclimatic reconstruction techniques and sources of paleo climatic information. Dating methods. Selected Paleoceanographic exercises of marine geological records.

Recommended Books:

Objectives:

To understand the process that lead to the generation of petroleum and to the accumulation of a viable oil field. To gain familiarity with the basic techniques of petroleum exploration.

Course Outline:


Lab. Work:


Recommended Books:

Objectives:

To describe the processes by which the Earth formed and continues to modify itself through Plate Tectonics. Explain supporting evidence for plate tectonics, the different types of plate boundaries, the driving forces, the resulting landforms, and the ocean basin cycle.

Course Outline:


Lab. Work:

Identify and describe observations related to the course. Local marine ecosystem or coastal habitats, or any sustainable or unsustainable practices related to marine habitats or organisms.

Recommended Books:

Objectives:

The Quaternary Period comprises the last 1.5 million years of Earth history, an interval dominated by climate fluctuations. Studies of Quaternary environments are increasingly important to understand the scale and rapidity of climatic and environmental changes in the modern world. This course will cover geologic evidence, that are used to reconstruct ocean and atmospheric conditions (e.g., temperature) through the Quaternary. Understanding of recent coastal deposits and coastal features within the context of Late Quaternary climate variability.

Course Outline:

Introduction to the Quaternary, Quaternary Stratigraphy Oxygen Isotope stratigraphy, biostratigraphy and magnetostratigraphy, glacial-interglacial cycles, eustatic changes, The oceanic record, Pleistocene sea level, proxy indicators of paleoenvironmental/paleoclimatic changes, Responses of geomorphic systems to climate, sea level and tectonics on variable time scales in the Quaternary., Quaternary dating methods, radiocarbon chronology, annual (varves, tree rings), Milankovitch Orbital cycles, D-O / H- events & last glacial termination (i.e., 20 - 7 ka), Ocean Circulation, neotectonics and their applications to natural coastal hazard assessment.

Lab. Work:

Study of the coastal areas of Pakistan.

Recommended Books:

Objectives:

The main aim is to understand the sea level changes processes and its effects on coastal environment. How a coastal system responds to different sea level variations scenarios. To understand the delicate and complex dynamics of coastal zones in relation to recent rise in sea level and associated coastal dynamics.

Course Outline:


Lab. Work:

Specified assignments/ projects.

Recommended Books:

Objectives:

To discuss the concept and limitations of basic theory for seismic wave propagation; to use principles of seismological instrumentation to select suitable equipment for various applications; and to locate the earthquake source and calculate in detail the mechanism from seismic observations.

Course Outline:


Lab. Work:

Specified assignments/projects.

Recommended Books:

Module V: Integrated Coastal Zone Management (ICZM)

Objectives:

To define ICM and the common terminology involved in discussing ICM principles and approaches; To explain the scope and functions of ICM and the typical actions relating to each function. To understand the principles of good governance, sustainable development.

Course Outline:

Introduction to the need for ICM and the link between social ecological systems and single sector development approaches. Terms and definitions: ICM and ICZM as defined by different organizations and experts, key terms in ICM including integrates, sustainable development, process versus project. Overview of the eleven principles that reflect the character and uniqueness of oceans and coasts under the three headings used by Cicin-Sains and Knecht (1998), plus additional information regarding more recent developments in ICM. Internationally accepted definitions for coastal zone and coastal waters: Internal waters, Territorial waters, Exclusive Economic Zone (EEZ), Continental shelf.

Lab. Work:

Identify and describe the objectives and functions of at least three important regional intergovernmental or non-governmental organisations/programs, or other regional cooperation initiatives, involved with coastal and marine area and/ or resources management. Group based discussion guided by a set of questions uncovering “Why is ICM needed?”

Recommended Books:

Objectives:

To explore how the predicted changes in climate during the present century may affect coastal ecosystems and to examine the likely impacts of climate change on mangroves and corals. To understand the basic concepts of climate change and resilience. To identify various ecosystems based tools for climate change adaptation.

Course Outline:

Terms and definitions: IPCC and UNFCCC, Climate Change, Weather and Climate. Overview on component on climate change covering principal components of global climate change that most affect coastal ecosystems: Carbon Dioxide, Acidification of the Oceans, Temperature, Sea Level Rise, Extreme Weather Events and Changes in Precipitation. Introduction to Disaster Risk Reduction for coastal communities. Why do disasters matter to sustainable development? Disaster trends. Explain the definitions of disaster, disaster risk, and disaster risk reduction making the linkages to climate change. Case study analysis to understand disaster risk. Explore why ecosystems matter to reducing disasters, including a comparison of Eco-DRR and Ecosystems Based Approach.

Lab. Work:

Comparative analysis of ecosystem-based adaptation and engineering options. Other case studies also available for lab exploration.

Recommended Books:

Objectives:

To understand the concept and components of resilience for providing conceptual framework for managing socio-ecological systems. To understand the basic concepts of disasters, disaster risk reduction and resilience. To identify various ecosystem based tools in reducing disaster risk and climate change adaptation.

Course Outline:

Importance of implementing resilience concepts, strategy building and planning, ecosystem services and reduction of vulnerability in disasters. The importance of DRR in reducing sensitivity and exposure and establishing systems for detection, response and recovery. How the integration of resilience data can secure and strengthen ecosystem service delivery, promote adaptation of ecosystems and economic activity. How data can support development of adaptation action plans, to measure and communicate changes over time etc. Introduction to Disaster Risk Reduction for coastal communities. Why do disasters matter to sustainable development? Disaster trends. Definitions of disaster, disaster risk, and disaster risk reduction making the linkages to climate change. Case study analysis to understand disaster risk. Why ecosystems matter to reducing disasters, comparison of Eco-DRR and Ecosystems Based Approach.

Lab. Work:

Comparative analysis of ecosystem-based adaptation and engineering options. Other case studies also available for lab exploration.

Recommended Books:

5. UNEP EBM guidance, EbA decision support framework:
Objectives:

To explore the opportunities and threats of coastal tourism development on coastal ecosystems and local communities and how these can be managed using tried and tested tools and the ICM approach.

Course Outline:

The connections between coastal tourism development and the impacts on local environments and communities. How the ICM principles and practices are applied to understand the tradeoffs involved in coastal tourism development using select case studies? Introduction to sustainable coastal management and tourism development. Understanding the linkages between coastal tourism development and the impacts on the local environment and local community. Understanding Carrying Capacity as an essential part of sustainable management decision making and the basic approach for managing tourism. Applying the ICM principles to explore the issues, threats and opportunities of coastal tourism development. Introducing recognized codes of conduct that support sustainable coastal tourism. Explore case studies that highlight good and bad practice in coastal tourism development.

Lab. Work:

Management Plan Exercises may be given.

Recommended Books:


Objectives:

To understand coastal zones, the dynamic environments shaped by natural forces as well as human intervention. To enable students to develop management strategies and identify threats to these environments.

Course Outline:


Lab. Work:

Case studies, Study of Regional legislation, Field trip to coastal areas and monitoring of beaches.

Recommended Books:

2. Clark, J.R., Coastal zone management handbook.
4. Sharma, P., Coastal Zone Management.
Objectives:

To introduce the concept and global experiences of Marine Protected Areas (MPA) management, as applied for marine biodiversity conservation, fisheries management, and sustainable tourism. To apply the concept of coastal use zonation and MPA management through a case study exercise of Mafia Island.

Course Outline:

Defining MPAs, Role of MPAs in protecting marine biodiversity, Types and categories of MPAs, Benefits from MPAs, Evidence of the positive impacts of MPAs, Best practice in establishing MPAs, MPAs and ICM, Zoning and MPAs, Use of GIS tools in marine spatial planning, Designing resilient MPAs and MPA networks, Case studies.

Lab. Work:

This course is taught with the aid of videos and class discussion and a working group activity. Working groups of 4-5 people students will read the case study of an island experiencing a number of emerging coastal management issues. Let students analyze the issues and describe the approach to be taken in finding solutions to the multiple and interlinked management issues. Presentation of work to the class.

Recommended Books:

Objectives:

To introduce coastal and marine spatial planning (MSP) as a tool/planning approach for ICM. To explore the nature of conflict and the principles of and approaches for conflict resolution as part of conflict management. To examine the nature of dispute resolution processes and practices. To understand the rational for conflict resolution in ICM.

Course Outline:


Lab. Work:

Conflict management and negotiation: role play exercise on conflict management in near shore fisheries management.

Recommended Books:

3. Thia-Eng, C., Essential elements of integrated coastal zone management.
4. FAO Corporate Document Repository; Title: Integrated coastal area management and agriculture, forestry and fisheries. Part E: Conflict resolution in integrated coastal area management. Produced by Natural Resources Management and Environment Department.
Objectives:

To explain the concept of governance; To review the institutional arrangements, relevant agencies responsible for coastal and marine resources management in Pakistan; To review the national legal framework, policies and regulations used to manage coastal and marine resources; To review the International Conventions ratified by Pakistan that support and necessitate sustainable coastal resource management.

Course Outline:


Lab. Work:

Institutional mapping exercise - outlining all relevant agencies/organizations that have a role in coastal marine resource management and their relationship to each other.

Recommended Books:

4. Relevant national environmental policies and regulations and international conventions and agreements.

SOCIAL EMPOWERMENT AND GENDER EQUALITY

Objectives:

To develop sensitization, awareness raising and the development of a common understanding re key gender concepts and definitions related to gender, sustainable development and the environment. To develop a basic understanding of the concept and methodology of gender integrated planning. The linkages between environmental sustainability and the Human Rights Based Approach (HRBA).

Course Outline:


Lab. Work:

Match gender concepts and definitions.

Recommended Books:

1. Anonymous, 2011. USAID Tips for Conducting a Gender Analysis at the Activity or Project Level Training Manual on Gender and Climate Change, IUCN, UNDP, UNEP, GGCA.
Objectives:

To consolidate their understanding of terminology used in ecology and to understand key ecological processes of high relevance and application in integrated coastal management. The course will identify and categorize the role and functions of natural ecosystems and their provision of ecosystem services and benefit to man; and to understand how human impacts on ecosystems can change the status and value of these services.

Course Outline:

An introduction to the fundamental concepts of ecosystem-based management, a systems-analysis approach, a) plant-animal interactions; b) trophic relationships; c) population dynamics; and d) species life cycle strategies (vital to conservation management). Relationship between people and the environment. Public attitudes, perceptions, and beliefs influence coastal management decision-making. Relationship between a community and its natural resources. Overview of the multidisciplinary approach to coastal ecosystems management. Role of social sub-systems e.g. culture, economic structure, demography etc. Millennium Ecosystem Assessment (MEA, 2005). How they relate to coastal ecosystems and ICM.

Lab. Work:

Identification of examples of both a Keystone species and a Flagship species associated with coastal or marine habitats in a country or region.

Recommended Books:

1. Ecological Principles.
2. Global Species Programe: how WWF classifies species.
Objectives:

To describe the ICM process or cycle, and explain each of the main stages in the ICM implementation cycle.

Course Outline:

Introduction to the five main stages of ICM process: 1) Situation analysis and issue identification; 2) Program/ Project planning and design; 3) Accepting and resourcing the plan; 4) Implementation; 5) Learning and evaluation. Detailed overview of each stage of ICM process outlining the linkage between the stages. Participatory Planning and Design Tools for ICM including: Situation Analysis Stakeholder Assessment and SWOT Analysis; Participatory Rural Appraisal/ Rapid Rural Assessment; Vulnerability Assessment; Systems thinking, analysis and approach; Spatial Assessment and Geographic Information System (GIS) - Use of GIS in coastal and marine area planning and management; Participatory project design and logical framework analysis and Theory of Change; and Monitoring and evaluation of ICM - ICM Indicators - ecosystem, governance, human well-being.

Lab. Work:

Specific assignments.

Recommended Books:

Module VI: Mangrovology (Mangl.)

BENTHIC ECOLOGY OF MANGROVES

Objectives:

To understand that benthic organisms are of ecological as well as of economic importance in mangroves and adjacent tidal flats. They affect internal nutrient cycling and exchange processes with adjacent ecosystems. Benthic fauna is a major food source for numerous juvenile fish and crustacean species and thus crucial for the survival of many commercially harvested species. In addition, benthic crabs and molluscs are important fisheries resources for the locals.

Course Outline:

General introduction: Taxonomy, anatomy, feeding strategies and life cycles
Food web and energy flow measurement
Biodiversity
Zonation patterns; temporal and spatial variation
Intra- and interspecific interactions
Stability of benthic communities
Impact of benthic organisms on carbon and nutrient cycling
Sampling design; uses and threats: Use of benthic resources
Natural and anthropogenic threats; pollution
Biological indicators of ecosystem health and resilience
Protection and sustainable use of resources; management issues
Re-colonization by benthic organisms.

Lab. Work:

Laboratory and field experiments, including field trips: Collection of epi- and endobenthic species using different sampling gears; Sample processing species; identification abiotic factors; and data processing and interpretation.

Recommended Books:

Objectives:

To understand that organisms dwelling in mangrove habitats are of ecological as well as of economic importance. They affect nutrient cycles and exchange processes. To identify mangrove associated flora and fauna that provide major food source for numerous juvenile fish and crustacean species.

Course Outline:

Introduction: Marine environment, Waves and tides, Understanding biodiversity; Diversity Assessment Methods, Mangrove Ecosystems, Biodiversity in Mangrove Ecosystems: Floral Diversity, Faunal Diversity; Brachyuran crabs in mangroves, Threats to Mangroves, Policy and Sustainable Management of Mangroves, Setting up a backyard hatchery for marine ornamental fish, Global Policies (Role of institutions, Conservation strategies in different countries).

Lab. Work:

Laboratory and field experiments Status, Practical work, including field trips to collect flora and fauna of mangrove habitats.

Recommended Books:

Objectives:

To understand mechanism and drivers of large scale coastal land reclamation in Pakistan and Southeast Asia; environmental impacts of coastal land reclamation and strategies for ecological improvement.

Course Outline:

Introduction: Context, Challenges, and Design Saliency. Comparison of the land reclamation history and trend between the developed and the developing countries. The broader ecological impacts of coastal land reclamation. Involvement of landscape architects, planners and ecologists in land reclamation. Landscape Planning and Design: Role of landscape architects and planners in the land use decision making; Opportunities for ecological improvements; Introduction to the cases studies. Strategies and Feasible Design Solutions: Developer’s perspective, Proposing solutions based on strong technicality, Land-fill substance and its influences on design solutions. Phasing and Implementation: ecological goals; Integrating ecological phasing; Long term monitoring and maintenance plan for sensitive habitats.

Lab. Work:

Field surveys.

Recommended Books:

CONSERVATION OF MANGROVE RESOURCES

Objectives:

This course provides students an opportunity to gain an appreciation of the scope and value of resources of mangrove ecosystems and their conservation and sustainable management. The course also addresses regulatory practices, which allow sustained use of these resources.

Types of marine resources: food, minerals and rare metals, oil and gas, chemicals, exotic products, natural wilderness; Uniqueness of the marine environment: relationship between aboriginal peoples and the sea; Major management and regulatory agencies: role of the government in maintaining marine resources, marine clubs and reserves, major and international treaties and regulations dealing with marine pollution, the history of global marine resource management during the twentieth century; Effective and/or ineffective management practices in turtle populations, the tuna industry, the prawning industry, the fishing industry, coral reefs, the whaling industry, coastal, estuarine and wetland development; Sustainable development; consequences of resource over-exploitation; renewable and non-renewable resources; sources of marine pollution including natural, industrial (including petroleum, marine litter, synthetic or organic compounds, pesticides, mining refuse), agricultural (including topsoils, pesticides, fertilisers), radioactive substances, conflict, community development (e.g. run off, etc.), ballast water; major disputes over the use of a particular resource.

Lab. Work:

To research and report on local uses of marine resources and local community needs, which place pressure on marine resources; to recognise and discuss the need for species diversification and ecological balance.

Recommended Books:


ECOLOGICAL MANGROVE REHABILITATION (EMR) 2+1=3 Crh

Objectives:

To introduce students regarding recently evolved concept of ecological mangrove rehabilitation (EMR) so that they may practice it.

Course Outline:

Introduction to Ecological Mangrove Rehabilitation (EMR), key biophysical factors, programme design, preliminary assessment, biophysical assessments, assessing resilience, design and planning, implementation, monitoring, international case studies.

Field visits of coastal communities living near mangrove habitats for experimenting rehabilitation activities.

Recommended Books:

Objectives:

To develop an awareness of the scope and importance of mangrove communities in Pakistan. Students should consider the vulnerability of these communities, threats to them and commercial exploitation.

Course Outline:

Physical features of a mangrove environment: distribution of mangroves in Pakistan, features of four mangrove species, adaptations of these mangrove species for salt water, aeration, seed dispersal, importance of mangroves to the life cycles of fish, crustaceans, molluscs, animals found among mangroves, threats to mangrove communities in Pakistan. Prospects and procedure of commercial activities in mangrove habitats like crab fattening, mariculture, pisciculture, silviculture (honey production) etc.

Lab. Work:

Field visits of mangrove habitats for experimenting commercial activities.

Recommended Books:

Objectives:

This course gives students the opportunity to study the important areas where salt and freshwater meet - the estuaries. It is an ideal change to explore the unique ecosystems found in estuarine systems.

Course Outline:
Nature of an estuary: merging of salt and fresh water, main ecosystems present open river, sea grass beds, tidal mudflats, mangrove and salt-water grass and mud lands, life form adaptations to the estuarine environment, estuaries as sources of food for marine organisms and as nurseries for many species of fish and crustaceans; Effects on estuaries of: urban and agricultural runoff, amateur and professional fishing, recreational activities, reclamation for development, flood mitigation and training wall construction; Suitable management practices that will protect estuarine environments; common techniques used to sample marine life in an estuary; Estuary life: common mangrove species, common crustaceans, fish found in estuaries; Importance of estuaries; Ecosystems present in estuaries; Techniques used to sample estuarine ecosystems.

Lab. Work:

To demonstrate common techniques used to sample marine life in an estuary; to map the features of a local estuary including ecosystems present; to extract animal life from mangrove mud (using sieves) to identify and analyse estuary life; to use a microscope to look for plankton and other microscopic life forms in river water; and to test mangrove mud for the presence of sulphide ions (S₂).

Recommended Books:

HUMAN IMPACT AND THREATS TO MANGROVE ECOSYSTEM

2+1=3 Crh

Objectives:

This course discusses various natural and human induced pressures and drivers of mangrove ecosystem degradation including deforestation, land reclamation, coastal erosion; environmental impacts of coastal land reclamation and strategies for ecological improvement. It will be useful for environmentalist and forest protection agencies for proper and effective management of mangroves.

Course Outline:

Human Impacts on Mangroves ecosystem: landuse change; Mangroves cutting; Coastal erosion; Mangroves Destruction, Degradation due to pollution; Long-term Effects of Mangrove Destruction, Human activities and natural processes that affect wetlands, Impact of Wetlands Loss. Surface water and groundwater, classifying water pollutants, effects of pollutants on water, pollution sources, auto awareness. Alternatives to household hazardous chemicals, sewage and solid waste dumping. A history of rubbish, oil spill clean-up, wheel of trouble. The rare scare - The road to extinction.

Lab. Work:

Field visits of different mangrove ecosystems to assess human impact on the habitats of mangroves and report writing.

Recommended Books:

MANGROVES AND CLIMATE CHANGE

2+1=3 Crh

Objectives:

This course will allow students to develop their knowledge on role of mangroves in climate change mitigation and adaptation.

Course Outline:

Mangroves in a changing climate: climate change impacts, mangrove role in climate change adaptation/mitigation (mangrove role in carbon cycle, carbon accounting and mangroves), increasing resilience of mangrove ecosystems to global change, vulnerability and risk reduction, Disaster Risk Reduction (DRR).

Lab. Work:

Methodology and planning of mangrove eco-tourism; Visitor survey techniques; Identification of eco-tourism sites; to write a report to describe ideas of planning ecotourism in the mangrove swamps, which incorporates the major assignments related to the field trip.

Recommended Books:

Objectives:

This course gives important information about mangroves forest management along the coastal area. It will be useful for environmentalist and forest protection agencies for proper management and protection of the mangroves.

Course Outline:

Introduction to Forest Resource Management; History of Mangroves Management in Pakistan; Forest Resource Health, Safety, Assessment and Mapping; Management Planning; Essential Field Skills; Introduction to Forest Ecology; Soil properties, development and organisms; ecology of the mangroves; Coastal Harvesting Systems; Introduction to Timber Cruising, Grading and Scaling; Worksite Readiness Skills; Transportation of Dangerous Goods.

Lab. Work:

Field visits of different mangrove forests; preparation of survey reports; to participate in the activities of mangroves transplantation.

Recommended Books:


**MS-Mangl-611 MANGROVE ECOTOURISM 2+1=3 Crh**

**Objectives:**

This course will allow students to develop their knowledge of all aspects of commercial and recreational activities *i.e.* the theoretical and practical aspects of development and management of mangrove based ecotourism for livelihood development of dependent communities.

**Course Outline:**

What is ecotourism and how does it relate to natural resource management; development of sustainable ecotourism facilities and services to be provided to visitors, local communities, economies, and the environment; Principle of marine and coastal eco-tourism, marine environment, important coastal habitats and tourism resources, coral reef, mangrove forests, *etc.*, development of mangrove eco-tourism, eco-tourism activities in marine areas, management of sustainable eco-tourism; planning and management frameworks for developing ecotourism opportunities on a site, community, and landscape level; how ecotourism activities impact natural areas and communities; and strategies and techniques to manage natural areas like coastal, creek or mangroves areas for recreation and tourism.

**Lab. Work:**

Methodology and planning of mangrove eco-tourism; Visitor survey techniques; Identification of marine eco-tourism sites; to write a report to describe ideas of planning ecotourism in the mangrove swamps, which incorporates the major assignments related to the field trip.

**Recommended Books:**


**MS-Mangl-612 MORPHOLOGY, PHYSIOLOGY AND ANATOMY OF MANGROVES 2+1=3 Crh**

**Objectives:**

This course introduces students to the morphology, physiology and anatomy of mangroves. Students have the opportunity to study in depth aiming to make themselves aware of the complexity of these plants and their adaptations.

**Course Outline:**

Types of Mangroves. Morphology of mangroves: modification of root, shoot and leaves. Physiology of mangroves: Roots and adaptation to water-logged conditions, energy production, photosynthesis and growth, excretion, respiration, salt regulation through salt glands, Reproduction (Pollination, Vivipary, Dispersal), Biomass. Anatomy of mangroves, anatomical structures, functions of these structures.

**Lab. Work:**

To list major systems present in a marine plant; to describe how the plant takes in minerals, produces organic compounds, removes waste, responds to stimuli; to recognise the importance of photosynthesis to marine plants. Morphology of leaves, leaf area, Section cutting and physiological experiments.

**Recommended Books:**

PRODUCTIVITY OF MANGROVE WETLANDS

Objectives:

This course introduces students to the importance of mangrove wetlands, which provide nursery grounds for several marine creatures.

Course Outline:

Mangrove forests and mangrove wetlands, Characteristic features of mangrove wetlands, Distribution of mangrove wetlands, Ecological factors influencing the mangrove wetland, Classification of mangrove wetlands (Classification of mangroves at the regional scale, Classification of mangroves at the micro level), Habitat and economic value of mangrove wetlands (Shoreline stabilisation, Shoreline protection, Detritus-based food web, Nursery ground for aquatic animals and fishery resources, Habitat for wildlife, Economic value).

Lab. Work:

Estimation of Primary productivity and secondary productivity of Mangrove Wetlands.

Recommended Books:

Objectives:

This course introduces students to the sedentary and migratory sea birds found along our coast. It is an introductory study of sea birds in general with a more detailed study of those species found in local area. This course is based upon observing and recording local marine bird life.

Course Outline:

Basic physiology of birds: bone structure in birds related to flight, the differences between bird and human lungs; Adaptations which allow birds to live successfully in and around water: flight, prolonged flight, wading on soft mud, swimming, camouflage, catching food; Observing and accurately recording these observations.

Lab. Work:

To use equipment appropriate for viewing sea birds at a distance; to identify birds that commonly seek food in mud flats, tributaries, sea shores, oceans; to construct a sighting log book listing date and time, location, name of bird, approximate numbers, main food, residency (permanent or migratory).

Recommended Books:

Module VII: Physical Oceanography (PO)

MS-PO-601 AIR-SEA INTERACTIONS 2+1=3 Chr

Objectives:

Oceanic and atmospheric mixed layers including fluxes of heat, momentum, moisture and salt between the ocean and atmosphere; vertical distribution of energy sources and sinks at the interface including the importance of surface currents; forced upper ocean dynamics, the role of surface waves on the air-sea exchange processes and ocean mixed layer processes.

Course Outline:

Laminar and turbulent flows; Reynolds stresses; Richardson's criterion for turbulence; principles of Prandtl's mixing length theory; Taylor's statistical theory and Kolmogoroffs similarity theory, Air Sea interaction at various scales; planetary and laminar boundary layer, surface layer and spiral layer; Sea surface as a lower boundary of air-flow and its geometry; wind field in the first few meters of the sea surface, wind structure in the maritime frictional layer; transfer of heat and water vapour; determination of air-sea fluxes; Obukhov Length Scales, Approximations, Role of SSTs, Precipitation and Evaporation, energy exchange and global heat and water budgets, convection and its role in tropical circulations, effects of upwelling and sinking on the ocean atmosphere system.

Lab. Work:

Specific problem may be given to exhibit Air Sea interaction.

Recommended Books:

5. Kraus, E.B., The Dynamics of the Upper Ocean.
Objectives:

This course acknowledges the high level of boat ownership in Pakistan and the economic importance of small boat operation. Students are given the opportunity to learn the basics of small boat operation and handling.

Course Outline:

Emergency and safety procedures: standard safety and distress signals, basic rescue and first-aid, procedures applicable to boating, important rescue agencies; the equipment required by law when, boating in enclosed and open water in NSW; seamanship; methods used to solve boating related problems: towing a trailer, basic maintenance procedures for a trailer, regulations governing safe passage of small craft on water, cardinal and lateral system of buoyage, regulations governing salvage, the use of basic knots and splices at sea, standard launching and landing, procedure from a ramp or slipway, loading and trimming a vessel correctly, determining the sea-worthiness of a vessel; the care and maintenance of boats and engines; the identification of areas of responsibility: responsibilities of small boat ownership, responsibilities of the driver or captain.

Lab. Work:

To plan a safe boating trip; to determine the latitude and longitude of a position on a chart; to explain how to locate one’s position using a transit bearing or a cross bearing fix; to determine the variation and deviation of a compass for a particular location and ship’s heading; to row a small boat, to fit an outboard motor to a small boat; to anchor and secure a small boat; to come alongside another vessel safely; to handle a small boat in windy conditions and with current and tidal flow use a compass in a boat; to demonstrate basic maintenance procedures for a trailer; to demonstrate the use of basic knots and splices; to participate in standard launching and landing procedure from a ramp or slipway; to prepare a boat for operation prior to launching; to load and trim a vessel correctly.

Recommended Books:

Objectives:

This course explores the science of climate change. Students will learn how the climate system works; what factors cause climate to change across different time scales and how those factors interact; how climate has changed in the past; how scientists use models, observations and theory to make predictions about future climate; and the possible consequences of climate change for our planet.

Course Outline:

Climate Work: An introduction to the concept of climate as a dynamic Earth system, how much of the Sun’s energy reaches the Earth, the greenhouse effect; Causes Climate to Change: Plate Tectonics, Earth’s Orbital Variations, Longlived Greenhouse Gases, Variations in Solar Luminosity, and Volcanic Eruptions; Response of the Climate System: Carbon Cycle and its Role in the Climate System; Numerical Modeling, Theory, and Observation to Understand Cause and Effect of Climate Change; Learning from the Past? Variations in Ocean and Lake Sediment Cores, Ice Cores, Corals, Tree Rings, and other Geologic Records; Potential Consequences, Risks, and Uncertainties of Climate Change: Sea Level Rise, Disruption of the Global Food Supply.

Lab. Work:

Specific laboratory assignments may be given.

Recommended Books:

Objectives:

This course introduces the physical principles underlying acoustic propagation in the sea and describes key applications. It draws on the internationally recognised marine acoustics programme.

Course Outline:

Background material; Noise in the ocean; Ray acoustics; Deep water acoustic propagation; Wave acoustics; Shallow water acoustic propagation; Devices for sound production and reception underwater; Sound production and reception by marine animals; Use of sound by marine animals; Impacts of man-made noise; Marine resource estimation; Marine environmental assessment; Defence applications of underwater acoustics; Commercial applications of underwater acoustics.

Lab. Work:

Specific assignments may be given to explore underwater acoustics.

Recommended Books:

Objectives:

This course provides better understanding of the natural hazards in the ocean environment and their relation to the relevant physical, meteorological geological processes including tsunamis, hurricanes and other storms, waves, coastal flooding, erosion, and climate change.

Course Outline:

Introduction to Natural Hazards; Hazard Energy Sources & Earth Interior, Earth Structure; Ocean Bathymetry and Plate Tectonics, Ocean Basin; Plate Tectonics (PT) and Earthquakes, Sea Floor; PT and Volcanoes; Mega-Volcanoes; Atmosphere/ Ocean System Dynamics; Ocean Conveyor Belt; Ocean Dynamics; The Gulf Stream; Ocean Waves; Tsunamis; Rogue Waves; Ocean Storms; Hurricanes Dynamics; Hurricanes Inundation, CSKatrina; Global Climate Change.

Specific assignments may be given.

Recommended Books:

Objectives:

The aim of this course is to help students, acquire an understanding of some of the basic concepts of fluid dynamics that will be needed as a foundation for advanced applications in ocean and atmospheric sciences and ocean engineering, etc. The emphasis is on fluid fundamentals, but with an atmosphere/ocean twist.

Course Outline:

Lab. Work:

Specific assignments may be given.

Recommended Books:

Objectives:

This course provides an introduction to numerical methods used to solve the equations of ocean motion. Topics of course range from basic numerical concepts to general transport and shallow-water equations to ocean circulation models that are employed to understand weather and climate.

Course Outline:


Lab. Work:

Work on assigned modelling problems and write a report for each. For the final project one can choose a topic of your interest, building on the material covered in the course. This project must include a written final report with a thorough discussion of numerical aspects, such as stability and error analysis.

Recommended Books:

Objectives:

In this course students learn about many of the physical processes that occur in the ocean, how these physical processes are observed, budgeted, and quantified? where these processes occur in the ocean? and access recent ocean datasets.

Course Outline:

Instruments, Fluids Mechanics, Rotation, Stratification, Vorticity balances, Ocean Circulation, Forcing, Wave Basics, Dispersive Wave Kinematics: Phase & Group velocity, Important kinds of ocean waves: surface gravity, internal gravity, Rossby, Kelvin Nonlinear waves, eddies, vortices, and coherent structures *El Nino*.

Lab. Work:

Specific assignments may be given.

Recommended Books:

Objectives:
This course provides information regarding ocean waves, tides and currents and use of instruments to measure them.

Course Outline:


Lab. Work:
Specific assignments may be given.

Recommended Books:

1. Ippen, A.T., Coastal and Estuarine Dynamics.
2. McClellan, Elements of physical Oceanography.
Objective:

This course provides an introduction to Physical Meteorology to understand atmosphere and different processes governing it.

Course Outline:

State of the atmosphere: Main constituents of dry air, carbon dioxide, ozone, ozone depletion, water vapour and aerosols; Vertical thermal structure of the atmosphere: Troposphere, stratosphere, mesosphere, thermosphere and exosphere; Environmental lapse rate; Standard atmosphere; Hydrostatic equilibrium; Hydrostatic equation; Geopotential; Equipotential surfaces.

Thermodynamics of dry air: Equation of state. Expansion of gas under constant pressure; Law of conservation of energy; specific heats of a gas; First law of thermodynamics; Adiabatic process in the atmosphere; Potential temperature; Equation state of dry air; poisson’s equation for dry air; Alternative forms of the energy equation; Entropy; Enthalpy.

Thermodynamics of moist air: The three states of water substances; The Classius and Clapeyron equation; Equation of state for water vapour; Moisture variables (Absolute humidity, specific humidity, relative humidity, mixing ratio); Relationship between Rm and Rd; Virtual temperature. Isobaric processes for moist air: Dew point temperature; Wet bulb temperature; Equivalent temperature; Adiabatic expansion of unsaturated air; Adiabatic expansion of saturated air. Vertical stability of the atmosphere: Dry adiabatic lapse rate; Standard adiabatic lapse rate; Equilibrium states; The parcel method; Application of the parcel method; Latent instability; The slice method; Relation between potential and latent instability; Stability of layers.

Solar Radiation: Characteristics of the sun; Nature of solar radiation; Definitions and concepts in radiation; Transfer of radiation through a medium; Terrestrial radiation; Characteristics of terrestrial radiation; Absorption of terrestrial radiation; Transmission of terrestrial radiation through the atmosphere; Simpson’s computation of terrestrial radiation transfer; Elsasser’s radiation chart; Radiative cooling or heating of the atmosphere; The mean heat balance of the earth - atmosphere system; The atmospheric green house effect.

Lab. Work:

Specific experiments.
Recommended Books:


**MS-PO-611** SATELLITE OCEANOGRAPHY 2+1=3 Chr

Objectives:

This course provides an introduction to Satellite Oceanography to substitute on board instruments to record various parameters of oceans.

Course Outline:

- Physical Principles of remote Sensing; Satellite Orbits; Sensors for forecasting the Ocean; Remote Sensing Program for satellite Meteorology and Oceanography; Principles of Image Processing; Passive sensors; Ocean colors and Remote Sensing; Passive microwave radiometers; Comparison between infrared and microwave radiometers for SST measurement; Air - Sea Interaction studies using satellite data; Radars, sea surface roughness and Scatterometry; Radar Altimeters from the Ocean; Synthetic Aperture Radar imaging of Ocean.

Lab. Work:

Specific assignments

Recommended Books:


**MS-PO - 612: Sea Level Changes and Coastal Zone**
(For description please refer to Module IV: MS-GO - 611)
Module VIII: Port Operations and Ship Management (POSM)

Objectives:

This subject introduces the fundamentals of the research process and covers the applications of qualitative and quantitative research methods. The purpose of this subject is to enable students to develop their skills of conducting a research independently.

Course Outline:

The role of business research; Scientific thinking and investigation - theory building, inductive and deductive reasoning; Difference between propositions and hypotheses; Concept of research process - preliminary data gathering, research problem/question definition, theoretical framework hypothesis development, scientific research design; Observational, experimental and case study research designs; Qualitative and quantitative research methodologies; Data collection methods; Questionnaire design; Measurement of variables - scaling, reliability and validity; Censuses and sampling; Probability and nonprobability sampling; Sampling frame; Response rate issues and non-response bias; Analysis and interpretation for qualitative and quantitative data; Parametric and nonparametric statistics for hypothesis testing; Bivariate correlation and simple linear regression. Research proposal and research report; Use of Harvard reference methods; Ethics of research; Plagiarism.

Lab. Work:

Use of statistical software packages.

Recommended Books:

Objectives:

To understand the economic aspects of maritime trade and shipping market.

Course Outline:

Maritime sector, its economic and marketing fundamentals; Economic organization of the shipping market; Supply, demand and freight rates; Financing ships and shipping companies; Economic principles of maritime trade; Global pattern of maritime trade; Bulk cargo and the economics of bulk shipping; General cargo and the economics of liner shipping; Regulatory framework of maritime economics; Economics of shipbuilding and scrapping; Marketing environment; Product life cycle; International product policy; International promotional policy; Overseas marketing channel policy; Geographical aspects of Pakistan coastline; Importance of oceans; Water Transport/ Water Ways; Role and significance of ports in maritime transport; Ports sector and ports in Pakistan & world and Major Trading Blocks of the World; The importance of ports to the national/ regional economy; Challenges in the maritime sector including globalization; Neglected areas and their improvement strategies; National legislation on maritime issues including National maritime Policy (NMP).

Lab. Work:

Marketing surveys.

Recommended Books:

Objectives:

To equip the students with the fundamentals of Strategic role of human resource management; Planning for human resources in dynamic environment; Acquisition and maintenance of human resources; Training and development; Trade unionism and employee welfare.

Course Outline:


Lab. Work:

Specific assignments may be given.

Recommended Books:

Objectives:

When students enter into the workforce, this strand has been designed to introduce students to the wide range of employment opportunities offered by marine and maritime industries.

Course Outline:

Marine employment opportunities: types of employment, entry requirements; maritime employment opportunities, education/training standards required for selection, post-school training details for the positions; advantages and disadvantages of shore and sea-based careers; features prospective employers may require in applicants; scholarships and traineeships available in the marine and maritime fields.

Lab. Work:

To investigate career opportunities in the marine and maritime industries, assess personal characteristics and traits in relation to the requirements of prospective employers; to search requirements for training, working conditions, rates of pay, hours of work for sea-going and shore-based positions.

Recommended Books:

4. Opportunities In Marine And Maritime Careers. Online.
Objectives:

To understand the legal structure and framework of the shipping industry and the ‘international’ aspect and complexity of regulating such a dynamic industry.

Course Outline:

History of Shipping, Shipping powers (Historical to present day); Ancient and medieval shipping laws, Evolution of modern shipping laws; Choice of courts and jurisdiction, Laws of the seas (UNCLOS); International maritime regulatory bodies e.g. IMO, MSC, MEPC, UNCTAD; International conventions e.g. SOLAS, MARPOL, Ratification of conventions and force of law; International conventions e.g. STCW, COLREGS, IALA, BUOYAGE; Important shipping organizations e.g. Intertanko, Intercargo, ITF, MPA; Important shipping organizations e.g. ILO, ICS, ISC, PSC, Flag States; Role of ‘BIMCO’, ‘The Baltic Exchange’, Lloyds of London; Description and role of International Association of Classification Societies, Institute of Chartered Shipbrokers.

Lab. Work:

Report Writing.

Recommended Books:

Objectives:

To discuss, in the context of maritime transport, the concept and development of modern logistics, including supply chain management, and marketing; to examine the specific position of shipping and ports in the logistics and supply chain.

Course Outline:

Concepts in supply chain management; Information technology for the supply chain; Decision support system for supply chain management; Logistics network design and planning; Inventory management in the supply chain; Risk pooling concept; Bullwhip effect in supply chain; Computerized beer game; Supply chain integration; Strategic alliance and partnering; Product and process design for logistics; International issues in supply chain management; Role of manager in supply chain; Aligning supply chain with business strategy; Elements of logistics and supply chain management (Transportation, Plant location, facility location and layout planning, maritime freight management); Effects of globalization on logistic industry; Baltic Freight Index; Developing technologies in logistics; Concepts of multimodal transport; Carrier alliances & partnerships; Multimodal logistic process; Regional & national patronage; National administrative control on Maritime Logistics; International regulatory framework, & international organizations like APH/ ISF/ ICS/ ITF; Familiarity with integrating Decision Support System (DSS) in managing the supply chain & Enterprise Resources Planning (ERP) and the integration of DSS and ERP for supply chain management; Evolution of maritime logistics in the context of maritime transport; Current trends in shipping logistics; Specific position of shipping and ports in the logistics and supply chain; International container trade; Marine transportation & its role in supply chain management.

Lab. Work:

Main analytical tools as well as decision making techniques of logistics and marketing and their applications in the shipping and port sector.

Recommended Books:

Objectives:

To equip students with the fundamentals of Maritime Safety and Security and related matters.

Course Outline:

Hazard and definition; Types of hazards, Transportation of hazardous goods; maritime casualties and reasons; threat and risk definitions; qualitative and quantitative risk assessment; methods of reducing risk; Emergency planning; Security concept/ regimes and management; Ship and port security procedures, ship and port security equipment; Ship security assessment and plan; Port security assessment and plan; Ship and port security officials, their tasks and responsibilities; Security documentation and registration; Security survey; Act/ ordinance, Regulations, Manuals, and International regulations on Criminality, Terrorism, Piracy, SOLAS, ISPS Contingency plans, DPA, ISM, SOLAS, MARPOL, Classification society & other international safety & security initiatives such as; 24 hour rule, CSI, C-TPAT & Mega-Port initiatives; Port state control, Coastal state, UNCLOS-III, & Other Maritime conventions.

Lab. Work:

Report writing.

Recommended Books:

Objectives:

The aim of this course is to provide a working knowledge of the principles, practice and management of present and future technologies in shipping industry.

Course Outline:

This course will discuss the fundamental engineering and related technologies relating to communications, power generation, propulsion, sea keeping, structures & ship systems that underpin the maritime industries. Contents of the module not limited to but include: Appreciation of Marine Machinery Systems; Materials; Casting, Welding, Non-destructive examination and measurement methods; Stress, Strain and Structural Analysis; Thermodynamic and Fluid Mechanics; Fuel, Combustion, Emissions and Environmental Considerations; Diesel Engines; Ship and Machinery Vibration and Noise; Ship Strength, Stability and Sea keeping; Ship Resistance and Propulsion; Ship Service Analysis; Energy Management; Electrical and Control Engineering; Condition Monitoring; Electronic Charting; Investigation and Failure Case Studies.

Lab. Work:

Specific assignments may be given.

Recommended Books:

Objectives:

This course gives students the basic knowledge enabling them to safely direct a boat at sea and introduces students to pilotage. It also gives them a basic understanding of the methods mariners use to safely direct their vessels inshore and offshore.

Course Outline:

Difference between piloting and navigation: how mariners use landmarks, buoys and marks to enter and leave port, directing a vessel at sea, encompassing piloting, inshore and offshore directing; navigational light requirements for vessels under way; the lateral and cardinal systems of buoyage; navigation charts and their symbols; basic navigation aids; ocean currents and navigation, how to locate one's position using a transit bearing, cross bearing fix; practical navigation, locating position using a transit bearing, cross bearing fix, the meaning of dead reckoning; the global current patterns; how ancient mariners used currents to their advantage? how the stars are used to navigate? the modern aids to navigation; international regulations for the prevention of collision at sea.

Lab. Work:

To identify navigational light requirements for vessels under way; to recognize the lateral and cardinal buoyage marks; to determine the latitude and longitude of a position on a chart; to use or simulate the techniques used in estimating one's position at sea etc.

Recommended Books:

Objectives:

To equip students with the fundamentals of the planning, design, development, operations and management process along with issues of ports and terminals.

Course Outline:

Role of ports in economic development and in the through transport concept; road/rail impact on port/hinterland relationships; port administration and free ports; the concept of dry-ports; demand analysis; capacity evaluation; productivity enhancement; Port Performance and Productivity including Port Performance Indicators (PPI) and Implementation of key performance indicators (KPIs); Environmental Impact Assessment; investment appraisal; information needs for port planning; aids to navigation; hydrographic aspects and vessel traffic management; investment criteria; investment analysis and financing; port authority liabilities, legal liability under national and international law; terminal design for the different principal cargo types; layout design models; storage facility planning models; port operations and pilotage, Input/output modes; management and organization; port marketing; cargo handling and transfer technology; data processing and communications technology; ship handling; docking and mooring systems; labour management in ports; planning for emergencies and disasters including safety & security.

Lab. Work:

Specific assignments may be given.

Recommended Books:

Louvain, Belgium, Garant.

**SHIP BROKERAGE,**

**CHARTERING AND**

**E-COMMERCE**

**Objectives:**

To give students a thorough understanding of ships and tanker brokerage, chartering and sale and purchase management in theory and in practice along with basics of e-commerce.

**Course Outline:**

Overview of the shipping market; composition of the freight market; participants in the freight market and their interests and concerns; market activities and indicators of the state of the market; Basic concepts of chartering; the role and liability of brokers; information network; orders, positions and freight market reports; chartering information centres and organisations; The period of investigation, offers and counter-offers; negotiation of main terms and details; subjects; post-fixture follow-up; Different types of charters; costs and risk allocation in different types of charters; standard charter-party forms; detailed analysis of standard charter party forms; practical considerations in drafting charter parties; rider clauses; Voyage estimating; comparing voyage charter income with time charter hire; lay-time calculation; ballast bonus; Sources of information for ship sale and purchase activities; the role of sale and purchase brokers, classification societies and independent valuators; marketing ships for sale; the commitment system; firm negotiation; sales terms; inspection and valuation of the ship; documentation; closing meeting; payment and delivery, deletion and registration; Major shipbuilding nations; the shipbuilding process; the new building contract; major demolition markets; demolition sales terms; payment and delivery; Advantages and disadvantages of second-hand vessels; Standard contracts for sale and purchase of vessels. Introduction to Technology Applications; E-Commerce and E-Business Concepts; Personal Technology Use; Enterprise Systems Technology and Infrastructure; The Wired World. Technology Convergence; Disruptive Technologies; Technical Solutions and Standards; Building E-commerce Solutions; Managing Business Value of Information Technology and E-commerce; E-commerce and Consumer Behaviour; E-commerce and Technology Use; Ethical, Social and Political Issues; Testing and Evaluating E-commerce Solutions.

**Lab. Work:**

Specific assignments may be given.

**Recommended Books:**
Objectives:

The objective of this course is to provide students an opportunity to understand the impact of shipping and shipping related activities on the environment, both sea and air; and to learn what the industry is doing to reduce this impact. The course will also look at what Singapore is doing in these areas to safeguard the marine environment.

Course Outline:

Causes of pollution to the marine and atmospheric environments due to shipping related activities; Environmental issues such as ship waste, oil pollution, anti-fouling paints, ship breaking activities, ship litter (including plastics), ballast water management and ship emissions and ship recycling; Role of shipping in relation to global issues like greenhouse gases & global warming; Current measures (both preventive and mitigating) adopted by the industry to tackle these issues along with national policy/ steps to safeguard our marine environment.

Lab. Work:

Specific assignments may be given.

Recommended Books:

Objectives:

This course introduces the framework and practices on various aspects of ship management, and marketing management for the shipping firm and tools for financial analysis of shipping investments are also introduced.

Course Outline:

Maritime transportation and cargoes; Uses of intermodal transport; Types of water carriers and freight transportation; Introduction to Shipping Practice; Agencies involved at various stage in Shipping & Port Procedure; Shipping Lines, Shipping Operations & Handling of Containers; Container Terminal Business Communication & Procedures; Fleet management; Technical management; Managing ship's maintenance & husbandry; Marketing management for the shipping firm: concepts, functions, and strategy; Tools for financial analysis of shipping investments; Ships registration & classification; Shipping costs and budgeting; Crewing & Manning; Marine Insurance, cargo claims and Risk management; Vessel Operations & commercial/technical issues; Bunker management & Voyage estimating related commercial practices; Contractual framework of international shipping; Occupational safety and safety of the environment; Bulk commodity logistics and services; Operations of container freight stations and inland container depots; Materials handling and packaging for maritime transport; Handling of hazardous and dangerous cargoes. Regulatory regimes in international shipping including codes like IMDG and code; Functions of liner conferences and bases for rates; Transshipment hub, logistical networks and feeder concepts; Non-vessel Operating Common Carrier (NVOCC); Documentation and logistics information systems; Security issues and related technology.

Lab. Work:

Specific assignments may be given.

Recommended Books:

RECOMMENDATIONS

The NCRC for marine science submitted following recommendations to be considered by HEC:

I. Admission Criteria in B.S. Marine Science
   A. Pre-requisite qualification should be Intermediate Science (or Equivalent) with minimum 2\textsuperscript{nd} Division from the following groups as per preference of order given below:
      i. Pre-Medical Group
      ii. Pre-Engineering Group
      iii. Other Groups (should have studied at least two subjects from Chemistry, Physics and Mathematics).
   B. Zero Semester would be offered to overcome students’ deficiency if required.

II. Compulsory Courses
   A. Weightage of English may be reduced from 12 to 6 credit hours.
   B. Urdu being the national language and as per decision of Supreme Court of Pakistan must be included.
   C. Biology should be included in the list of compulsory courses.
   D. Citizenship Education and Community Engagement should be included in the list of compulsory subjects and one credit hour out of three credit hours should be given for community services (Project work).

III. Nomenclature of Degrees
   A. Associate Degree [68 credit hours would be completed in two years (four semesters)].
   B. B.S. Degree [124-136 credit hours would be completed in four years (eight semesters)].
   C. If a candidate obtains prevalent B.Sc. degree and wants to join B.S. programme, can join in 5\textsuperscript{th} semester through bridging (after attending 15 to 18 credit hours’ deficiency courses).
   D. If a candidate obtains Associate degree and wants to join B.S. programme, can join in 5\textsuperscript{th} semester.

IV. Inclusion of new disciplines
   A. Being maritime country the B.S. programmes should be extended to following specializations in 7\textsuperscript{th} and 8\textsuperscript{th} semester to be added among the elective modules:
      i. Biological Oceanography and Conservation (BOC)
ii. Chemical and Environmental Oceanography (CEO)
iii. Fisheries and Aquaculture (FA)
iv. Geological Oceanography (GO)
v. Mangrovology (Mangl)
vi. Integrated Coastal Zone Management (ICZM)
vii. Physical Oceanography (PO)
viii. Port Operations and Ship Management (POSM)

B. Field Project/ thesis/ Internship (to be reflected in transcript)
   i. Field Project would be substituted by one course.
   ii. Thesis would substitute two courses of two different semesters.
   iii. Internship can be offered in summer/ winter vacations that would substitute a course to be ratified by assessment report.

V. Suggestions regarding promotion of research in M.Sc./B.S. and M.Phil./M.S. programmes:

A. That the research activities should be started from M.Sc./ B.S. programme by including six Cr.h. research as part and parcel of the programme wherein community may be involved and their problems can be addressed.

B. That the M.Phil./M.S. programmes should be a blend of course and research work being the intermediate phase between courses and research. Awarding M.Phil./ M.S. merely on the basis of courses and certain CGPA is unjust as it would produce learned force having no creativity.

C. That students involved in research work at the level of B.S./ M.Sc. should be given preference in admitting M.S./ M.Phil. course. In that the student who have not done research work either at the level of B.S./ M.Sc. or M.S./ M.Phil. should not be allowed to take admission in Ph.D.

D. That the research activities need proper funding for field visits and laboratory investigations where means of transportation, appropriate equipments and chemicals are indispensable pre-requisites. Admission in research oriented degrees should be avoided if such facilities are lacking.

E. That the involvement of social sector is important but it should be confined to social science and not to pure as well as applied science. If we have to involve social sector then it should be
under Corporate Social Responsibility (CSR) with the collaboration of industries so that spirit of scientific research may not be jeopardized. There should be a liaison among academia, industry and community so that research activities may focus on future needs of country and the nation pave the way towards self reliance.

F. That the culture of scientific research should not be curbed by involving community based interactions both in research grants and research works. Converting scientific research into social service is a clear contravention to its doctrine.

G. That the HEC-Pakistan may write to governmental, non governmental agencies and different stakeholders to create job opportunities for fresh graduates/postgraduates of marine science. The HEC should also give equivalence certificates to graduates so that they may apply against various vacancies.

In the light of above facts the NCRC-HEC for marine science requests the HEC-Pakistan to make policies in accordance with the Biovision Championing Agenda 2030 of UN, wherein 17 Sustainable Development Goals (SDGs) were set in contrast to the Millennium Development Goals (MDGs) for industrialised as well as developing and emerging countries. The MDGs were not beneficial for our country; therefore, we should follow the Biovision of SDGs.
# GENERAL BIOLOGY (BIOL.-301)
## LIST OF EXPERIMENTS FOR THE SESSION 2015 - 2016

<table>
<thead>
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<th>S. No.</th>
<th>Inv. No.</th>
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<td>1</td>
<td></td>
<td>Microscope</td>
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<td>1.</td>
<td>1.1</td>
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<td>To study and handle a compound microscope.</td>
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<td>2.</td>
<td>1.2</td>
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<td>To calibrate a compound microscope for micrometry.</td>
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<td>II</td>
<td>2</td>
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<td>Life forms</td>
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<td>3.</td>
<td>2.1</td>
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<td>To introduce Phytophagy.</td>
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<td>4.</td>
<td>2.2</td>
<td></td>
<td>To study some plant specimens (Solanaceae &amp; Mimosaceae).</td>
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<td>5.</td>
<td>2.3</td>
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<td>To study some algal organisms (Field study, Seaweeds).</td>
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<td>2.4</td>
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<td>To study some animal specimens (Field study).</td>
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<tr>
<td>III</td>
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<td></td>
<td>Plasmolysis and Deplasmolysis</td>
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<td>7.</td>
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<td>To study plasmolysis and deplasmolysis in plant cells.</td>
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<td>8.</td>
<td>3.2</td>
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<td>To study plasmolysis and deplasmolysis in blood cells.</td>
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<td>IV</td>
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<td></td>
<td>Gram Staining</td>
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<td>9.</td>
<td>4.1</td>
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<td>To prepare a smear of bacterial culture and staining it.</td>
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<td>10.</td>
<td>4.2</td>
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<td>To perform Gram staining to differentiate Gram positive and Gram negative bacteria.</td>
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<td>V</td>
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<td>Study of Fungi</td>
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<td>11.</td>
<td>5.1</td>
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<td>To prepare slide and identify the fungus from given culture.</td>
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<td>VI</td>
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<td>Study of Cell Division</td>
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<td>12.</td>
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<td>To study mitosis in onion root tip.</td>
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<td>13.</td>
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<td>To study meiosis in Grasshopper testis.</td>
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<td>VII</td>
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<td>Identification of Chemical Nature of Living Organisms</td>
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<td>14.</td>
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<td>To determine Rf value of plant extract by chromatography.</td>
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<td>15.</td>
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<td>To study the phenomenon of Imbibition in plant material.</td>
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<td>To test the presence of sucrose in plant material.</td>
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<td>To test the presence of carbohydrates in plant material.</td>
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<td>To test the presence of proteins in plant material.</td>
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<td>Protein Digestion</td>
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<td>To demonstrate protein digestion by enzyme pepsin.</td>
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<td>Cytochemical Studies</td>
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