UNIVERSITY OF MUMBAI
No. UG/ 94 of 2016-17

CIRCULAR:-

A reference is invited to the Syllabi relating to the M. Sc. degree programme, **vide** this office Circular No. UG/119 of 2015-16, dated 5th November, 2015 and the Head, University Department of Bio-Technology and the Principals of affiliated Colleges in Science and the Head of the recognized Science Institutions concerned are hereby informed that the recommendation made by Ad-hoc Board of Studies in Life Science at its meeting held on 30th May, 2016 has been accepted by the Academic Council at its meeting held on 24th June, 2016 **vide** item No. 4.47 and that in accordance therewith, revised syllabus as per Choice Based Credit System in the course of M.Sc. Life Science (Marine Biotechnology Specialization) (Sem. III & IV), which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

(Dr.M.A.Khan)
REGISTRAR

MUMBAI – 400 032
October, 2016

To,

The Head, University Department of Bio-Technology and the Principals of affiliated Colleges in Science and the Head of the recognized Science Institutions concerned.

A.C/4.47/24/06/2016

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No. UG/94 -A of 2016-17 MUMBAI-400 032 25th October, 2016

Copy forwarded with compliments for information to :-

1) The Dean, Faculty of Science,
2) The Director, Board of Colleges and University Development,
3) The Professor-cum-Director, Institute of Distance and Open Learning(IDOL),
4) The Controller of Examinations,
5) The Co-Ordinator, University Computerization Centre.

(Dr.M.A.Khan)
REGISTRAR

PTO..

AC 24 / 06 /2016
Item No. 4.47

UNIVERSITY OF MUMBAI

Syllabus for the

M.Sc. Part – II: Life Sciences

(Marine Biotechnology)

Semester III and IV

Choice Based Credit System (CBCS)

The academic year 2016-17

M.Sc. Part - II Life Sciences Syllabus

(Marine Biotechnology)

The Academic year 2016-2017

SEMESTER III

COURSE CODE	UNIT	TOPIC HEADINGS	CREDITS	L / WEEK
Paper I	**COASTAL AQUACULTURE**			
PSLSMBT301	I		4	4
	II			4
	III			4
	IV			4
Paper II	**FRESHWATER AQUACULTURE**			
PSLSMBT302	I		4	4
	II			4
	III			4
	IV			4
Paper III	**NON FOOD AQUACULTURE**			
PSLSMBT303	I		4	4
	II			4
	III			4
	IV			4
Paper IV	**AQUACULTURE NUTRITION AND FEED TECHNOLOGY**			
PSLSMBT304	I		4	4
	II			4
	III			4
	IV			4

SEMESTER II

COURSE CODE	UNIT	TOPIC HEADINGS	CREDITS	L / WEEK
Paper I	**SEED PRODUCTION AND HATCHERY MANAGEMENT**			
PSLSMBT401	I		4	4
	II			4
	III			4
	IV			4
Paper II	**AQUATIC ANIMAL HEALTH MANAGEMENT**			
PSLSMBT402	I		4	4
	II			4
	III			4
	IV			4
Paper III	**ADVANCES IN FISH GENETICS AND BIOTECHNOLOGY**			
PSLSMBT403	I		4	4
	II			4
	III			4
	IV			4
Paper IV	**AQUACULTURE DEVELOPMENT PLANING AND MANAGEMENT**			
PSLSMBT404	I		4	4
	II			4
	III			4
	IV			4

M.Sc. LIFE SCIENCES: PART – II

PAPER – I (PSLSMBT301): COASTAL AQUACULTURE

UNIT I
Introduction: An overview of the status of coastal aquaculture; Present trend and scope in India. Different farming systems: Cage and pen culture, Raft and rack culture

UNIT II
Important cultivable finfishes: Distribution, biology, seed collection, nursery rearing, culture techniques, problems and prospects (seabass, milkfish, mullets, pearlspot, sea breams, rabbitfish, grouper, yellowtail, eel, cobia, salmon, flatfish etc).

UNIT III
Culture of marine molluscs and echinoderms: Present status and scope in India, Species cultured (mussels, oysters, pearl oysters, scallops, clams, cockles, abalones, sea cucumber) distribution, biology, practices followed in India,

UNIT IV
Culture of crustaceans and Molluscs: Shrimp farming: systems of farming – extensive, semi-intensive and intensive; site selection, infrastructure requirement, design and construction of culture systems, pond preparation, stocking, feed and water quality management, disease prevention and treatment; harvesting and handling Farming methods of Pearl oysters - off-bottom and on-bottom culture; Problems and prospects.

UNIT VI
Seaweed culture: Major seaweed species of commercial importance; methods of culture; farming of agar, algin, carrageenan yielding species; emerging trends in their farming in open seas; Integration with other farming systems.

Practicals:

1. Identification of cultivable marine and brackishwater finfish/shellfish
2. Identification of cultivable seaweeds
3. Soil sampling, determination of soil moisture and bulk density,
4. Analyses of mud acidity and soil texture
5. Soil analysis for temperature, pH, conductivity, salinity, transparency, turbidity and solids
6. Chlorophyll estimation from seaweeds
7. Visits to fishing harbor to study local finfish and shellfish species

Suggested Readings

Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication

Bardach EJ, Rhyther JH & Mc Larney WO. 1972. *Aquaculture the Farming and Husbandry of Freshwater and Marine Organisms*. John Wiley & Sons.
FAO. 2001. *Planning and Management for Sustainable Coastal Aquaculture Development*. FAO Publ.
Gilbert B. 1990. *Aquaculture*. Vol. II. Ellis Horwood.
ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
Pillay TVR. 1990. *Aquaculture, Principles and Practices*. Fishing News Books.
Pillay TVR & Kutty MN. 2005. *Aquaculture: Principles and Practices*. 2nd Ed. Blackwell.
Shepherd J & Bromage N. 1990. *Intensive Fish Farming*. B.S.P. Professional Books.

PAPER – II (PSLSMBT302): FRESHWATER AQUACULTURE

UNIT I
Introduction: Present status, problems and scope of fish and prawn farming in global and Indian perspective. Aquaculture systems: Extensive, semi-intensive and intensive culture of fish, Pen and cage culture in lentic and lotic water bodies, polyculture, composite fish culture.

UNIT II
Fish farming: Nursery and grow-out, pond preparation, stocking, feeding and water quality management in the farming of major and minor carps, magur, tilapia, etc.; Stunted seed production and culture practice.

UNIT III
Freshwater prawn farming: Monoculture practice of prawn in ponds, all male culture and its advantages, polyculture with carps, prawn farming in inland saline soils. Nursery rearing, sex segregation, pond preparation, stocking, feeding and water quality management, disease prevention and treatment; harvesting and handling.
UNIT V
Integrated farming systems: Design, farming practices, constraints and economics of IFS of fish with paddy, cattle, pig, poultry, duck, rabbit, etc. Wastewater-fed aquaculture: Water treatment methods, species selection, culture practices, harvesting and depuration process.

Practicals:

1. Identification of commercially important fresh water finfish/shellfish
2. Water analyses (pH, dissolved oxygen, alkalinity, salinity and hardness)
3. Pathogen (Bacterial and fungal) analysis of diseased carps/ prawns
4. Estimation of primary productivity and chlorophyll from water sample
5. Visit to freshwater fish prawn farms

Suggested Readings

AAHRI. 1998. *Health Management in Shrimp Ponds*. Aquatic Animal Health Research Institute (AAHRI), Department of Fisheries, Thailand.
Agarwal SC. 2008. *A Handbook of Fish Farming*. 2nd Ed. Narendra Publ. House.
Beveridge MCM & Mc Andrew BJ. 2000. *Tilapias: Biology and Exploitations*. Kluwer.
De Silva SS. (Ed.). 2001. *Reservoir and Culture Based Fisheries: Biology and Management*. ACAIR Proceedings.
FAO. 2007. *Manual on Freshwater Prawn Farming*.
Midlen & Redding TA. 1998. *Environmental Management for Aquaculture*. Kluwer.
New MB. 2000. *Freshwater Prawn Farming*. CRC Publ.
Pillay TVR. 1990. *Aquaculture: Principles and Practices*. Fishing News Books, Cambrige University Press, Cambridge.
Venugopal S. 2005. *Aquaculture*. Pointer Publ.

Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication
Welcomme RL. 2001. *Inland Fisheries: Ecology and Management*. Fishing News Books.

PAPER –III (PSLSMBT303): NON-FOOD AQUACULTURE

UNIT I
Aquarium fish trade: Present status; potential; major exporting and importing countries; species-wise contribution of freshwater and marine fishes; contribution of culture and capture; marketing strateg
Breeding techniques: Reproductive biology, captive breeding and rearing of freshwater, brackishwater, marine ornamental fishes

UNIT III
Aquarium keeping: Design and construction of tanks; species-wise tank size requirement; heating, lighting, aeration and filtration arrangements; decorations used; common aquarium plants and their propagation; Feed, health and water quality management; prophylaxis; quarantine.

UNIT IV
Value addition: Colour enhancement; genetic manipulation and production of new strains; hybrids; acclimatization strategies for marine ornamental fish to freshwater. Ornamental aquatic plants: Propagation methods, nutrient and environmental requirement, cropping methods, packing and transport.

Practicals:

1. Identification of common freshwater aquarium fishes
2. Identification of common brackish and marine aquarium fishes
3. Identification of ornamental aquatic plants.
4. Histological changes in the gonads ofsexually immature and mature fish
5. Visit to Aquarium museum
6. Feed preparation of aquarium fish feed

Suggested Readings

Axelrod HR & Vorderwinkler W. 1978. *Encyclopaedia of Tropical Fishes*.TFH Publ.
Axelrod HR & Sweenen ME. 1992. *The Fascination of Breeding AquariumFishes*. TFH Publ.
Axelrod HR. 1967. *Breeding Aquarium Fishes*. TFH Publ.
ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
Mills D. 1981. *Aquarium Fishes*. Kingfisher Books.
Sanford G & Crow R. 1991. *The Manual of Tank Busters*. Salamander Books.
Saxena A. (Ed.). 2003. *Aquarium Management*. Daya Publ.
Spotte S. 1979. *Fish and Invertebrate Culture*. John Wiley & Sons.
Thabrow De WV. 1981. *Popular Aquarium Plants*. Thornbill Press.
Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication

PAPER – IV (PSLSMBT304): AQUACULTURE NUTRITION AND FEED TECHNOLOGY

UNIT I

Fish nutrition: Principles of fish nutrition and terminologies, Role of nutrients: amino acids, fatty acids, proteins, lipids, carbohydrates, vitamins and minerals. Nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and adults.

UNIT II

Nutritional bioenergetics: Fish as an open thermodynamic system, Energy requirement of fishes, protein to energy ratio, digestible energy, nitrogen balance index, protein sparing effect, high energy feeds, isocaloric diets, Energy budgets, Energetic efficiency of fish production.

UNIT III

Feed formulation: Conventional and non conventional feed stuffs, feed formulation technology, growth promoting agents in aqua feed, Feed additives (attractants, growth stimulants and probiotics and binders), Antinutritional factors and antimetabolites, microbial toxins, methods of elimination, nutrient deficiency and symptoms.

UNIT IV

Larval nutrition: Nutritional requirements of fish and shellfish larvae, quality requirements of larval feeds (particle size, digestibility), natural food and its importance in aquaculture, nutritional quality of commonly used fish food organisms, (bacterioplankton, phytoplankton and zooplankton) and their roles in larval nutrition, culture of single cell proteins and their nutritional quality, Microparticulate diets.

Practicals:

1. Moisture and ash content of Fish/ shrimp/feed
2. Estimation of protein from fish/prawn tissue by Folin - Lawry method
3. Estimation of crude protein by Kjeldahl method
4. Lipid content of fish/prawn/feed by Bligh and Dyer methos
5. Estimation of crude fibre, nitrogen free extract
6. Estimation of Vitamins A/Thiamin from the feed ingredients.
7. Estimation of calcium and phosphorus content of feed;
8. Determination energy content of feed
9. Analysis of mycotoxins from feedingredients/feed
10. Formulation and preparation of a balanced fish feed; Feeding trials

Suggested Readings

ADCP (Aquaculture Development and Co-ordination Programme). 1980. *Fish Feed Technology*. ADCP/REP/80/11. FAO.

Cyrino EP & Bureau D & Kapoor BG. 2008. *Feeding and Digestive Functions in Fishes*. Science Publ.

D' Abramo LR, Conklin DE & Akiyama DM. 1977. *Crustacean Nutrition: Advances in Aquaculture*. Vol. VI. World Aquaculture Society,
Baton Roughe, De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.
Elena M. 2003. *Nutrition, Physiology and Metabolism in Crustaceans*. Science Publishers.
Guillame J, Kaushik S, Bergot P & Metallier R. 2001. *Nutrition and Feeding of Fish and Crustaceans*. Springer Praxis Publ.
Halver J & Hardy RW. 2002. *Fish Nutrition*. Academic Press.
Halver JE & Tiews KT. 1979. *Finfish Nutrition and Fishfeed Technology*. Vols. I, II Heenemann, Berlin.
Hertrampf JW & Pascual FP. 2000. *Handbook on Ingredients for Aquaculture Feeds*. Kluwer.
Houlihan D, Boujard T & Jobling M. 2001. *Food Intake in Fish*. Blackwell.
Lavens P & Sorgeloos P. 1996. *Manual on the Production and Use of Live Food for Aquaculture*. FAO Fisheries Tech. Paper 361, FAO.
Lovell RT. 1998. *Nutrition and Feeding of Fishes*. Chapman & Hall.
New MB. 1987. *Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture*. FAO – ADCP/REP/87/26.
NRC (National Research Council). 1993. *Nutrient Requirements of Fish*. National Academy Press, Washington.
Ojha JS. 2005. *Aquaculture Nutrition and Biochemistry*. Daya Publ.

SEMESTER IV

PAPER- I (PSLSMBT401): SEED PRODUCTION AND HATCHERY MANAGEMENT

UNIT I

Introduction: History, constraints and current status of natural seed collection and hatchery seed production of Finfishes and shellfishes

UNIT II

Finfishes (Mullet, Carps, Tilapia etc) Gamete maturation and development: Spermatogenesis and oogenesis, Hormonal pathways and mode of control. Environmental and endocrine control of reproduction: Reproductive cycles, Seasonality (Photoperiod, change in water quality and quantity, temperature, lunar cycle, etc.), Environmental and exogenous hormonal stimuli.

Induced spawning: Brood stock availability, Methods of natural and artificial fertilization, GnRH andLinpe models, evaluation of milt and egg, cryopreservation technique, use of different synthetic hormones and analogues for induced spawning, Egg staging, Stripping and fertilization.

UNIT III

Shelfishes (Prawns, Shrimp, oysters): Reproductive biology: Gonad anatomy, endocrinology and reproductive mechanisms in prawns, shrimps, oysters etc. Age at first maturity; factors affecting maturation and spawning.

Broodstock: availability; improvement; nutritional requirements; transport; captive rearing and maturation; induced spawning; physical and chemical inducing agents; physiology and techniques of eyestalk ablation

Seed production: Brood stock availability, Seed production of commercially important prawns, shrimps, oysters etc.

UNIT IV

Hatchery design and management: Criteria for site selection of hatchery and nursery, Design and function of incubators, Jar hatchery, Chinese hatchery and other hatchery systems- design and operation, hatchery protocols, larval rearing stages, rearing technology, packaging and transport of seed.

Practicals:

1. To study histological changes in the liver/gonads of fish
2. Eyestalk ablation technique of shrimp/prawn,
3. Insemination, Cryopreservation of fish and shellfish gametes
4. Collection and identification of cultivable brackishwater finfish seed;
5. Packing and transportation of cultivable finfish seed
6. Visit to different finfish hatcheries

Suggested Readings

FAO. 1992. *Manual of Seed Production of Carps*. FAO Publ.
ICAR. 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
Jhingran VG & Pullin RSV. 1985. *Hatchery Manual for the Common, Chinese and Indian Major Carps*. ICLARM, Philippines.
Jhingran VG. 1991. *Fish and Fisheries of India*. Hindustan Publ.
Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*.Blackwell.
Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
Thomas PC, Rath SC & Mohapatra KD. 2003. *Breeding and Seed Production of Finfish and Shellfish*. Daya Publ.**AQC**
CMFRI Bulletin. 1987. *National Seminar on Shellfish Resources and Farming*.
FAO. 2007. *Manual for Operating a Small Scale Recirculation Freshwater Prawn Hatchery*.
ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
Ujwala Jadhav (2010): Aquaculture Technology and Environment. Publ. PHI Publication
Bardach EJ, Rhyther JH & Mc Larney WO. 1972. *Aquaculture. The Farming and Husbandry of Freshwater and Marine Organisms*. John Wiley & Sons.
Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*. Daya Publ. House.
Diwan AD, Joseph S & Ayyappan S. 2008. *Physiology of Reproduction, Breeding and Culture of Tiger Shrimp*. Narendra Publ. House.
Gilbert B. 1990. *Aquaculture*. Vol. II. Ellis Harwood.

PAPER- II (PSLSMBT402): AQUATIC ANIMAL HEALTH MANAGEMENT

UNIT I
Defense mechanism in fish and shellfish: Specific and non-specific defense mechanism, immunogenicity, immune cells, immune suppressant, ontogeny of immune system; cellular adaptation, pathogen specificity.

UNIT II
Disease diagnostics tools: Histopathological methods, tools used in different types of PCR, Immunoassay, Biochemical assay, Monoclonal and polyclonal based antibody assay, Electron microscopy, Serological techniques.

UNIT III
Disease prevention and therapeutics: Vaccines and bactericins, development of vaccines like DNA vaccine, adjuvants, etc;

UNIT IV
Administration and mode of action of pathogen specific drugs, drug resistance, antiviral drugs, drug regulation in India, pharmacokinetics and pharmacodynamics, immunostimulants.

Practicals:

1. Microbial analysis of diseased fish/prawn skin mucus
2. Isolation of microbial DNA from fish pathogens
3. Sandwich ELISA of fish/prawn pathogens
4. Agglutination test
5. Histopathology changes in the organs of diseased fish/prawn

Suggested Readings

Andrews C, Excell A & Carrington N. 1988. *The Manual of Fish Health*. Salamander Books.
Sindermann CJ. 1990. *Principal Diseases of Marine Fish and Shellfish*. Vols. I, II. 2nd Ed. Academic Press.
Jorge E, Helmut S, Thomas W & Kapoor BG. 2008. *Fish Diseases*. Science Publ.
Felix S, Riji John K, Prince Jeyaseelan MJ & Sundararaj V. 2001. *Fish Disease Diagnosis and Health Management*. Fisheries College and Research, Institute, T. N. Veterinary and Animal Sciences University. Thoothukkudi.
Humphrey J, Arthur JR, Subasinghe RP & Phillips MJ. 2005. *Aquatic Animal Quarantine and Health Certification in Asia*. FAO Publ.
Inglis V, Roberts RJ & Bromage NR. 1993. *Bacterial Diseases of Fish*. Blackwell.
Iwama G & Nakanishi T. (Eds.). 1996. *The Fish Immune System - Organism, Pathogen and Environment*. Academic Press.
Roberts RJ. 2001. *Fish Pathology*. 3nd Ed. WB Saunders.
Shankar KM & Mohan CV. 2002. *Fish and Shellfish Health Management*. UNESCO Publ.
Wedmeyer G, Meyer FP & Smith L. 1999. *Environmental Stress and Fish Diseases*. Narendra Publ. House.

Woo PTK & Bruno DW. (Eds.). 1999. *Fish Diseases and Disorders*. Vol. III. *Viral, Bacterial and Fungal Infection*. CABI

PAPER- III (PSLSMBT403): ADVANCES IN FISH GENETICS AND BIOTECHNOLOGY

UNIT I

Scope of applied fish genetics: Inheritance of qualitative and quantitative traits in fish; chromosomal polymorphism. Non chromosomal inheritance: Mitochondrial inheritance. Chromosome manipulation: Gynogenesis and androgenesis; production of super-males and transgenic fish.

UNIT II

Genetic markers: Use of biochemical and molecular genetic markers in hybridization, selective breeding.

Diallele crossing: Genetic improvement of particular trait (disease resistance) in fish.

Chromosome banding techniques: C-banding, G-banding, NOR-banding, FISH.

UNIT III

Feed biotechnology: Probiotics, single cell proteins, Nutraceuticals. Recombinant proteins of commercial importance: enzymes, hormones, bioactive compounds, therapeutic proteins. Anti microbial Peptides and their applications.

UNIT IV

Vaccination in fishes- DNA vaccines, sub UNIT vaccines and Biofilm Vaccines.

Applications of biotechnological tools: Recombinant DNA, Monoclonal antibodies, Cell lines and stem cell culture, DNA markers and MAS.

Practicals:

1. To study polymorphism in fish/Prawn using RAPD markers
2. Isolation of single cell protein by salting out method
3. Estimation of Ascorbic acid from seaweeds
4. Amplification of 16s RNA from fish pathogens
5. To study different chromosome banding pattern in fish/prawn (Demonstration)
6. Antimicrobial properties of Mollusc/Crab aqueous extracts

Suggested Readings

Das P & Jhingran AG. 1976. *Fish Genetics in India*. Today & Tomorrow Publ.
Douglas T. 1998. *Genetics for Fish Hatchery Managers*. Kluwer.
Dunham RA. 2004. *Aquaculture and Fisheries Biotechnology Genetic Approaches*. CABI.
Malvee S. 2008. *Fish Genetics*. SBS Publ.
Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*. Dominant Publ.
Padhi BJ & Mandal RK. 2000. *Applied Fish Genetics*. Fishing Chimes.

Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publ.
Reddy PVGK. 2005. *Genetic Resources of Major Indian Carps*. Daya Publ.
Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna. 2005. *Text Book of Fish Genetics and Biotechnology*. ICAR.
Sinnot EW, Dunn L & Dobzansky T. 1989. *Principles of Genetics*. Mc Graw Hill.
Felix S. 2007. *Molecular Diagnostic Biotechnology in Aquaculture*. Daya Publ. House.
Fingerman M, Nagabhushanam R & Thompson MF. 1997. *Recent Advances in Marine Biotechnology*. Vols. I-III. Oxford & IBH.
Glick BR & Pasternak JJ. 1999. *Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology*. ASM Press.
Nagabhushanam R, Diwan AD, Zahurnec BJ & Sarojini R. 2004. *Biotechnology of Aquatic Animals*. Science Publ.
Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*. Dominant Publ.
Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publ.
Primrose SB. 1989. *Modern Biotechnology*. Blackwell.
Ramesh RC. (Ed.). 2007. *Microbial Biotechnology in Agriculture and Aquaculture*. Vol. II. Science Publ.
Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna. 2005. *Text Book of Fish Genetics and Biotechnology*. ICAR.
Singh B. 2006. *Marine Biotechnology and Aquculture Development*. Daya Publ. House.
Zhanjiang JL. 2007. *Aquaculture Genome Technologies*. Blackwell.

PAPER- IV (PSLSMBT404): AQUACULTURE DEVELOPMENT PLANING AND MANAGEMENT

UNIT I

Importance, principles and processes in developing aquaculture programmes; Planning for sustainable development; Types of planning; Planning strategies at various levels - Top down and bottom up approaches. Role and relevance of Panchayati Raj institutions in aquaculture development; Plan allocation and performance of FFDA, BFDA and other aquaculture related programmes over the different plan-periods in India.

UNIT II

Project preparation and project appraisal in terms of social benefit analysis, shadow prices; Project management techniques - PERT and CPM; Logical framework approach (LFA), Stakeholder analysis; Participatory Monitoring and evaluation (PROME); People's participation in aquaculture programmes, significance, importance and approaches .

UNIT III

Critical analysis of aquaculture and rural development programmes; design, operation, institutional mechanism and socio-cultural and economic impact of programmes such as NREGA; labour market relations; Fisheries development *vis-à-vis* fisheries for development; Livelihood Frameworks.

Practical:

Research Project

Suggested Readings

Agarwal SC. 2004. *Fishery Management*. APH Publ. Corp.
Agarwal SC & Johal S. 2003. *Fishery Development*. Narendra Publ.
Felix S. 2007. *Aquaculture Management Techniques*. Daya Publ. House.
Singh B. 2007. *Fishery Management: Planning and Objectives*. Vista International Publ. House.
Sinha VRP. 2005. *Fisheries Research Planning and Management in Developing Countries*. Narendra Publ. House.

OVERALL EXAMINATION AND MARKS DISTRIBUTION PATTERN

SEMESTER III

	COURSE CODE												
Theory	**PSLSMBT301**			**PSLSMBT302**			**PSLSMBT303**			**PSLMBT304**			**GRAND TOTAL**
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	**PSLSMBP301**			**PSLSMBP302**			**PSLSMBP303**			**PSLSMBP304**			
	-	50	50	-	50	50	-	50	50	-	50	50	200

SEMESTER IV

	COURSE CODE												
Theory	**PSLSMBT401**			**PSLSMBT402**			**PSLSMBT403**			**PSLSMBT404**			**GRAND TOTAL**
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	**PSLSMBP401**			**PSLSMBP402**			**PSLSMBP403**			**PSLSMBP404**			
	-	50	50	-	50	50	-	50	50	-	50	50	200