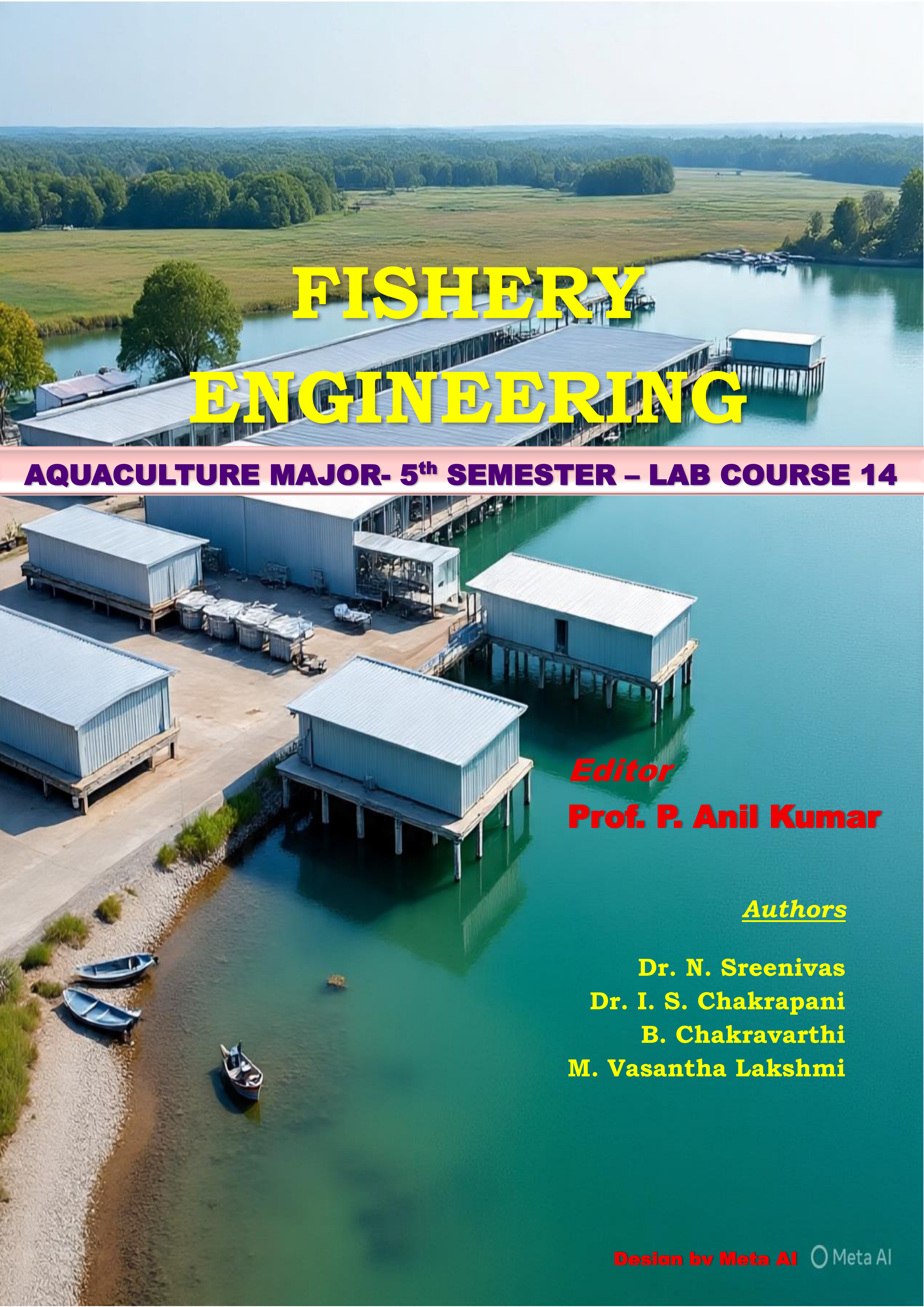

FISHERY ENGINEERING

AQUACULTURE MAJOR- 5th SEMESTER – LAB COURSE 14

Editor

Prof. P. Anil Kumar

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FISHERY ENGINEERING

AQUACULTURE MAJOR

5th SEMESTER – LAB COURSE 14

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PRACTICAL

Experiment 1A:
Site survey: preparation of site map

A site survey is a crucial initial step in any construction, development, or mapping project. The process involves collecting precise measurements and data about the physical features of a specific piece of land. This information is then used to create detailed maps, including site plans and contour maps, that are essential for planning, design, and construction.

This worksheet helps in evaluating potential sites for fish farming in the Kakinada region. It includes key ecological, biological, operational, and socio-economic factors to ensure proper site selection and sustainable aquaculture development.

Section A: Site identification and location details

Parameter	Response
Date of Survey	[Date of survey]
Survey Team	[Names and roles of the survey team members]
Location (District, Mandal, Revenue Village, Survey No.)	Kakinada District, [Mandal Name, Revenue Village Name, Survey Number]
GPS Coordinates (if available)	Latitude: [Latitude], Longitude: [Longitude]
Existing Land Use (e.g., Agricultural, Fallow, Waste Land, Waterlogged)	[Example: Low productive agricultural land, prone to inundation]
Total Area of Proposed Site	[Total area in hectares (ha)]
Proposed Water Spread Area (max 80% of total area for freshwater)	[Water spread area in hectares (ha)]

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Section B: Water source and quality

Parameter	**Observation/Data**	**Recommended Range (where applicable)**	**Potential Challenges/Opportunities**
Water Source(s)	[Example: Irrigation canal, drainage channel, borewell (for supplementing evaporation losses only)]	Stable, adequate, and perennial supply preferred. Minimum supply of 5 l/sec/ ha of pond throughout the year.	[Example: Intermittent supply, risk of floods, borewell dependence]
Water Quality Parameters (from analysis of source water)			
- Temperature	[Value in degrees Celsius (°C)]	25 - 35°C	[Example: High fluctuations, risk of extreme temperatures]
- pH	[Value]	7.0 - 8.6	[Example: Slightly acidic, potential need for liming]
- Dissolved Oxygen (DO)	[Value in milligrams per liter (mg/L)]	4 - 10 mg/L	[Example: Low DO, potential need for aeration]
- Salinity	[Value in parts per thousand (ppt)]	<5 ppt (for freshwater aquaculture)	[Example: Brackish water, suitability for specific species only]
- Ammonia	[Value in parts per million (ppm)]	0 - 0.1 ppm	[Example: High levels, indicating potential pollution]
- Other parameters (TDS, BOD, Heavy	[Values]	Depends on the parameter	[Example: Presence of heavy metals from industrial effluent]

Metals, Pollutants)			
Water Availability (Year-round/Seasonal)	[Example: Year-round, dependent on rainfall]		[Example: Water scarcity during dry season]
Water Drainage Possibilities (Gravity/Pumping)	[Example: Gravity drainage possible]	Gravity drainage preferred.	[Example: Requires pumping, increasing costs]

Section C: Soil characteristics

Parameter	**Observation/Data**	**Recommended Range/Characteristics**	**Potential Challenges/Opportunities**
Soil Type/Texture	[Example: Sandy clay loam]	Ideal soil types include loamy, clay loamy, and silt clay, with sandy clay to clayey loam being considered the best.	[Example: High sand content, poor water retention]
Soil pH	[Value]	For carp culture, a pH of 6.5 - 7.5 is recommended. Alkaline pH levels of 7 and above are preferred to avoid issues associated with acidic soils.	[Example: Acidic soil, requiring liming]
Water Retention Capacity	[Example: Good]	Clay, clay loam, silty clay, and sandy clay soils generally have good water retention.	[Example: Poor water retention, leading to high seepage]
Organic Carbon	[Value]	0.5-2.0%	[Example: Low organic carbon, indicating low fertility]

Sub-Surface Layers (presence of problematic layers like gravel, sand)	[Example: No problematic layers observed]	Sites with rock outcrops, gravel beds, sandstone, or limestone should be avoided.	[Example: Presence of gravel layers, requiring engineering solutions]
Soil Permeability (for dyke construction)	[Value in cm/sec]	A coefficient of permeability less than k = 5 × 10-6 m/sec is recommended.	[Example: High permeability, potential for dyke instability]

Section D: Topography and land characteristics

Parameter	**Observation/Data**	**Recommended Characteristics**	**Potential Challenges/Opportunities**
Land Topography (Slope, Flatness)	[Example: Gently sloping]	Slopes should ideally not be steeper than 2 percent.	[Example: Steep slopes, requiring extensive earthworks]
Flood Risk	[Example: Low risk]	The land should not be prone to deep flooding, and the maximum flood level from the past 10 years should remain below the top of the dikes.	[Example: Prone to flooding, requiring higher dykes and protective measures]
Proximity to Natural Drainage/Flood Channels	[Example: Located 50m from a natural drainage channel]	Aquaculture farms should not impede natural drainage or flood channels, preventing flooding in low-lying areas and villages.	[Example: Close proximity, potential for obstruction or pollution]

Underground Utilities/Obstacles (pipelines, power lines, etc.)	[Example: No observed underground utilities]	Avoid sites with underground utilities.	[Example: Presence of oil pipeline, rendering site unsuitable]
Vegetation Type and Density	[Example: Grassland with some shrubs]	Sites with grassland, abandoned paddy fields, open woodland, or low shrubs and bushes are more cost-effective for construction.	[Example: Dense jungle, increasing clearing costs]
Proximity to Industrial Zones or Polluted Areas	[Example: Located 5 km away from the nearest industrial zone]	The site must be free from pollution sources such as industrial or domestic waste.	[Example: Close proximity, risk of water pollution]

Section E: Biological and operational factors

Parameter	**Observation/Data**	**Considerations**	**Decisions/Recommendations**
Target Species for Culture	[Example: Rohu, Catla, Mrigal]	Consider suitability for local climate and water conditions, as well as market demand.	[Example: Primarily freshwater carps due to water source]
Type of Culture System (e.g., Pond, Cage, Bio floc)	[Example: Earthen Pond culture]	Select based on site characteristics, water availability, and management goals.	[Example: Pond culture due to suitable soil and water availability]

Availability of Quality Seed/Fingerlings (local sources)	[Example: Reputable hatcheries nearby]	Ensure access to reliable sources of disease-free stocking materials.	[Example: Establish relationships with local certified hatcheries]
Availability of Feed and Other Inputs (fertilizers, chemicals)	[Example: Feed suppliers in Kakinada city]	Evaluate the proximity and cost-effectiveness of input sources.	[Example: Develop a network of local suppliers]
Post-Harvest Management Facilities (cold storage, transportation)	[Example: Access to cold storage in Kakinada port]	Assess the availability of infrastructure for handling, preservation, and transport.	[Example: Utilize existing cold storage facilities and explore direct marketing]

Section F: Economic and social factors

Parameter	**Observation/Data**	**Considerations**	**Decisions/Recommendations**
Land Ownership and Legal Status	[Example: Clear land title, no legal restrictions]	Verify clear title, absence of legal disputes, and compliance with regulations.	[Example: Secure long-term lease or ownership]
Proximity to Markets	[Example: 20 km from Kakinada Fish Market]	Consider minimizing transportation costs and ensuring access to buyers.	[Example: Explore options for direct selling or collaborate with wholesalers]

Availability of Skilled/Unskilled Labor	[Example: Local availability of skilled labour]	Assess the availability of a reliable workforce.	[Example: Provide training to local youth for skilled labour]
Availability of Essential Services (Electricity, Roads, Water)	[Example: Electricity access available, all-weather road connection]	Evaluate the presence of infrastructure for efficient operation and farm accessibility.	[Example: Ensure reliable electricity supply and maintain road access]
Local Community Acceptance and Support	[Example: Positive community perception of aquaculture]	Gauge local attitudes and potential social impacts of aquaculture.	[Example: Engage with the local community to build positive relationships]

Section G: Regulatory and environmental compliance

Parameter	**Observation/Data**	**Compliance Requirements**	**Actions Needed**
Registration with District Level Committee (DLC)	[Example: Application submitted]	Required for freshwater aquaculture in Andhra Pradesh.	[Example: Follow up on the application status]
Water Pollution Control Board (APPCB) Norms	[Example: Regular monitoring of effluent discharge]	Effluent discharge must meet prescribed standards.	[Example: Implement best management practices for water quality control]
Andhra Pradesh WALTA Act, 2002 (Water, Land, and Trees Act)	[Example: Permission for borewell usage secured]	Ensure compliance with regulations on water usage, especially groundwater.	[Example: Regularly renew necessary permits]

Andhra Pradesh Aquaculture Seed (Quality Control) Rules, 2020	[Example: Sourcing seed from registered hatcheries]	Adherence to quality standards for aquaculture seed is required.	[Example: Maintain records of seed procurement and quality checks]
Environmental Impact Assessment (if required)	[Example: Pre-feasibility report submitted]	Compliance with environmental regulations and procedures.	[Example: Follow up on clearance procedures]

Section H: Overall assessment and recommendations

Based on the survey data, provide a comprehensive assessment of the site's suitability for the proposed fish farming activity, considering both opportunities and risks. Offer specific recommendations for necessary improvements, mitigations, and further investigations required for the successful establishment and operation of the fish farm.

Overall Suitability Score:

[Example: 4/5 (Highly Suitable) ………. or 2/5 (Moderately Suitable)]

Recommendations:

1. **[Specific Recommendation 1**: e.g., Conduct detailed soil analysis to confirm water retention capacity]
2. [**Specific Recommendation 2**: e.g., Develop a comprehensive water management plan to address seasonal variations]
3. **[Specific Recommendation 3**: e.g., Explore options for securing long-term land lease]
4. **[Specific Recommendation 4**: e.g., Engage with the local community to address potential concerns]
5. **[Specific Recommendation 5:** e.g., En sure compliance with all regulatory requirements before commencing operations]

This worksheet serves as a guide for conducting a thorough site survey for aquaculture development in the Kakinada region. Remember to adapt it to the specific context of your project and consult with experts from institutions like the State Institute of Fisheries Technology for specialized guidance.

Experiment 1b. Contour surveying

Definition

Contour is an imaginary line on the ground joining the points of equal elevation. It is a line in which the surface of ground is intersected by a level surface. “A contour line is a line on a map representing a contour”.

A pond with water at an elevation of 100 m. If the water is lowered by one meter another water mark representing 99.00 m elevation will be obtained. These water marks may be surveyed and represented on the map in the form of contours. A topographic map represents a clear picture of the surface of the ground. If a map is to a big scale, it shows where the ground is nearly level where it is sloping, where the slopes are steep and where they are gradual. If a map is to a small scale, it shows the flat country.

Contour interval

The vertical distance between any two consecutive contours is called the contour interval. The contour interval is kept constant for a contour plan; otherwise the general appearance of the map will be misleading. The horizontal distance between two points on two consecutive contours is known as the horizontal equivalent and depends upon the steepness of the ground.

The contour intervals depend upon the following considerations.

- Nature of ground
- Scale of the map
- The purpose and extent of the survey
- Time and expense of field and office work

Nature of ground

The contour interval depends upon whether the country in flat or highly undulated. For very flat ground, a small interval is necessary. If the ground is more broken, greater interval should be adopted, otherwise the contours will become too close to each other.

Scale of the map

The contour interval should be inversely proportional to the scale. If the scale is small, the contour interval should be large. If the scale is large the contour intervals should be small.

The purpose and extent of the survey

The contour interval largely depends upon the purpose and the extent of the survey. For example, if the survey is intended for detailed design work or for accurate earth work calculations small contour interval is to be used. In this case extent of survey will be generally small. In the case of location survey, for lines of communication for reservoir and drainage areas, where the extent of survey is large, a large contour interval is to be used.

Time and expense of field and office work

If the time available is less, greater contour interval should be used. If the contour interval is small greater time will be taken in the field survey in reductions and in plotting the map.

Methods of locating contours

There are two methods for locating contours

- The direct method
- The indirect method

Direct method, the contour to be plotted is actually traced on the ground. Only those points are surveyed which happed to be plotted. This method is slow and tedious. It is used for small areas and where great accuracy is required.

The direct method is divided into two forms.

- Vertical control: Location points
- Horizontal control: Survey of those points.

Vertical control

The points on the contours are traced with the help of a level and staff. The level is set at a point to command the area as much as possible and is levelled. The staff is kept on the B.M and the height of the instrument is determined. If the B.M (Bench Mark) is not nearby fly levelling may be performed to establish a temporary bench mark (T.B.M.) in that area. Having known the H.I the staff reading is calculated so that the bottom of the staff is at an elevation equal to the valve of the contour.

E.g.: H.I =101.80 meter, the reading to get a point on the contour of 100.00 m elevation will be 1.80 m. Taking one contour at a time, the staff man is directed to keep the staff on the points on contour so that reading of 1.80 m is obtained every time.

Indirect method

In the indirect method some suitable guide points are selected and surveyed, the guide point need not necessarily be on the contours. These guide points having been plotted serve as a basis for the interpolation of contour.

In this method, some guide points are selected along a system of straight lines and their elevations are found. The points are then plotted and contours are then drawn by interpolation. There are three indirect methods in locating contours.

- By squares
- By cross-sections
- By Tachometric methods

By squares

This method is used when the area to be surveyed is small and the ground is not very much undulating. The area to be surveyed is divided into number of squares.

The size of the squares may vary from 5 to 20 m depending upon the nature of the contour and contour interval. The elevations of the corners of the square are then determined by means of a level and a staff. The contour lines may be drawn by interpolation.

Interpolation of contour

Interpolation of the contours is the process of spacing the contours proportionately between the plotted ground points established by indirect methods. The methods of interpolation are based on the assumption that the slope of ground between the two points is uniform.

Following are the three methods of interpolation.

- By estimation
- By arithmetic calculation
- By graphical method

By estimation

This method is extremely rough and is used for small scale work only. The position of contour points between the guide points are located by estimation.

By arithmetic calculation

This method so accurate and is time consuming. The positions of contour points between the guide points are located by arithmetic calculation

e.g. A, B, C and D be the guide points plotted on the map. Elevations at each point are 607.4, 617.3, 612.5 and 604.3 respectively. Let AB=BD, CD=CA= one inch on plan. The vertical difference in elevation between A and B is (617.3-607.4) = 9.9 feet. Hence the distance of the contour points from A will be calculated as follows

i.e., 1/x * y*z

where,
x= Difference in contour elevation between two points
y= The distance between two points
z= The distance between the starting point to contour line

Distance of 610 feet contour point says A1 is calculated by interpolation using the
formula,

- The difference in contour elevation between two points is (617.3-607.4) = 9.9 feet.
- The distance between the two points = 2.0m
- The distance between the starting point to contour line is 610- 607.4 = 2.6 feet
- Distance from point „A‟ is = (1/9.9) x 2.6 x 2 = 0.52 m

These contour points may be located on AB the contour points for any lines can be calculated.

Contour surveying: Uses of contour

Following are the some of the uses of contour map,
Drawing of section

- Determination of inter-visibility between two points
- Tracing of contour gradients and location of route
- Measurement of drainage area
- Calculation of reservoir capacity

Experiment 2. Ice making and harvesting

This worksheet outlines a protocol for efficient and hygienic ice making and harvesting in fisheries operations, particularly in the context of Kakinada, aiming to maintain optimal ice quality for fish preservation.

Section A: Ice production information

Parameter	**Response**
1. Ice Plant Location	[Name of Ice Plant/Vessel Location in Kakinada]
2. Date of Ice Production	[Date]
3. Type of Ice Produced	[Example: Flake ice, Block ice, Tube ice, Slush ice]
4. Daily Production Capacity	[Capacity in tonnes/kg per 24 hours]

5. Water Source for Ice Production	[Example: Potable tap water, Borewell water (with treatment details)]
6. Water Treatment Process (if any)	[Example: Filtration, Chlorination (specify ppm)]
7. Freezing Method	[Example: Brine tank, Refrigerated drum/surface, Evaporator tubes]

Section B: Ice quality control

Parameter	Observation/Testing Method	Standard/Desired Outcome	Corrective Action (if needed)
Appearance	[Example: Clear, translucent, free from foreign matter]	Ice should be clean and free from discoloration or visible impurities.	Improve water quality treatment or ice plant hygiene.
Taste/Odor	[Example: Tasteless, odourless]	Ice should be free from any off-tastes or odours.	Check water source and treatment process for potential contaminants.
Temperature of Ice (before use)	[Value in degrees Celsius (°C)]	Ideally close to 0°C or slightly subcooled for flake ice (-5° to -7°C).	Adjust refrigeration system settings if needed.
Particle Size (if applicable, for crushed block ice or small ice)	[Example: Less than 1 cm x 1 cm for flake ice or crushed block ice]	Optimal particle size ensures good contact with fish and prevents damage.	Use appropriate ice crushing machine or method if using block ice.
Microbial Load (if testing facilities available)	[Colony-forming units (CFU)/gram or milliliter]	Within acceptable limits for food safety standards.	Enhance sanitation and hygiene practices during ice

			production and handling.

Section C: Ice harvesting and handling

Parameter	**Procedure/Practice**	**Check (Yes/No)**	**Remarks/Observations**
Personal Hygiene of Ice Handlers	Proper hand washing, use of gloves and clean attire.	Yes/No	[Example: Workers wearing clean gloves]
Equipment Sanitation (shovels, buckets, conveyors, storage bins)	Regular cleaning and sanitization of all equipment that comes in contact with ice.	Yes/No	[Example: Equipment cleaned daily with disinfectant]
Storage Conditions of Harvested Ice	Insulated containers/bins, maintained at low temperatures to minimize melting.	Yes/No	[Example: Ice stored in well-insulated bin to prevent melting]
Prevention of Cross-Contamination	Separate storage and handling areas for ice and fish. Avoid contact with soiled surfaces.	Yes/No	[Example: Designated areas for ice and fish to prevent contamination]
Safe Lifting and Transport of Ice	Use appropriate lifting equipment (e.g., pallet jacks, fork-lift trucks) for large containers. Secure containers during transport.	Yes/No	[Example: Using mechanical means to load ice onto vessels]
Ice Plant Sanitation	Regular cleaning and disinfection of the ice plant facility. Keep a record of cleaning and disinfection.	Yes/No	[Example: Ice plant cleaned thoroughly after each production batch]

Section D: Use of ice on board fishing vessels/in processing plants

Parameter	**Procedure/Practice**	**Check (Yes/No)**	**Remarks/Observations**
Fish Handling before Icing	Sorting by species and size, careful handling to prevent bruising. If possible, eviscerate and bleed fish before icing.	Yes/No	[Example: Fish sorted and bled before icing]
Ice to Fish Ratio	Maintain an appropriate ice to fish ratio, ideally 1:1 in tropical conditions, but varies depending on trip length and type of fish. In tropical climates, 1 kg water: 2 kg ice: 6 kg fish is used in insulated tanks or tubs.	Yes/No	[Example: Maintaining a 1:1 ice to fish ratio on board]
Layering of Ice and Fish	Place a layer of ice at the bottom, then alternate layers of fish and ice, ensuring fish are completely surrounded. The ice should be placed around the sides of the box as well as amongst the fish and the top layer of fish should be covered with at least 5 cm of ice.	Yes/No	[Example: Fish are fully covered with ice to minimize exposure to air]
Storage Temperature Maintenance	Monitor and maintain the temperature in the fish hold or containers at or below 0°C. Use insulated containers or holds to minimize heat gain.	Yes/No	[Example: Temperature checks ensuring fish are kept at optimal temperature]
Drainage of Melt Water	Ensure adequate drainage to remove meltwater and fish juices, preventing contamination and discoloration of fish gills.	Yes/No	[Example: Meltwater drained regularly from the fish hold]

Unloading and Transport of Iced Fish	Careful unloading and transfer to avoid physical damage to the fish. Use insulated containers for transport to market or processing plant to maintain the chill chain.	Yes/No	[Example: Fish unloaded carefully and transported in insulated boxes to the market]
Cleaning and Sanitization of Hold/Containers	Thoroughly clean and sanitize the fish hold or containers after each use. Do not reuse old ice.	Yes/No	[Example: Fish hold cleaned and disinfected before the next trip]

Section E: Record keeping

Record Type	**Frequency**	**Responsibility**
Ice Production Logs (Date, Time, Quantity, Water Source)	Daily/Per Batch	Ice Plant Supervisor
Water Quality Test Results (Source Water and Ice Water)	Weekly/Monthly	Ice Plant Supervisor/Quality Control
Cleaning and Sanitation Records (Ice Plant, Equipment, Holds/Containers)	Daily/After Each Use	Designated Personnel
Ice Usage Logs (Quantity Used, Fish Species, Destination)	Per Fishing Trip/Per Batch	Vessel Skipper/Processing Plant Manager
Temperature Monitoring Records (Fish Hold/Containers)	Continuously during storage	Vessel Crew/Processing Plant Personnel

Instructions:

- This worksheet can be adapted based on the specific type of fishing operation (e.g., small-scale artisanal vs. large-scale industrial), the species being handled, and the available facilities.
- Compliance with national and international food safety regulations is essential. In India, Export Inspection Council guidelines and FAO recommendations for ice in fisheries can be used as references.

- Training of personnel involved in ice making, handling, and use is crucial to ensure adherence to proper protocols.
- The effectiveness of ice in fish preservation depends significantly on the speed and efficiency with which it is used after fish capture.
- Proper insulation of fish holds and storage containers is vital, especially in warm climates like Kakinada, to minimize ice melting and maintain the chill chain.

This detailed worksheet will help ensure best practices in ice making and harvesting, thereby enhancing the quality and safety of fish products from Kakinada.

Experiment 3. Testing different netting materials- natural and synthetic

Evaluating the performance of netting materials, whether natural or synthetic, involves a range of tests to assess their strength, durability, and response to various environmental conditions.

This worksheet outlines a protocol for testing different netting materials, both natural and synthetic, commonly used in marine and inland fisheries. This evaluation helps fishermen and researchers choose the most suitable materials for specific fishing gear and conditions.

Section A: Material information

Parameter	**Material 1 (Natural - e.g., Cotton/Jute)**	**Material 2 (Synthetic - e.g., Nylon/PE)**	**Material 3 (Synthetic - e.g., Biodegradable Polymer)**	**Material 4 (Optional)**
Material Type	[Example: Cotton (multifilament)]	[Example: Nylon (monofilament)]	[Example: Biodegradable co-polyester]	[Example: HDPE (Polyethylene)]
Yarn Construction (e.g., Mono/Multifilament, Knotted/Knotless)	[Example: Multifilament, knotted]	[Example: Monofilament, knotted]	[Example: Monofilament, knotless]	[Example: Multifilament, knotted]
Twine Diameter/Size	[Value in mm]	[Value in mm]	[Value in mm]	[Value in mm]
Mesh Size (if applicable, for nets)	[Value in mm]	[Value in mm]	[Value in mm]	[Value in mm]
Supplier/Manufacturer	[Name and location]	[Name and location]	[Name and location]	[Name and location]

Cost per Unit Weight/Length	[Cost in INR/Kg or /Meter]	[Cost in INR/Kg or /Meter]	[Cost in INR/Kg or /Meter]	[Cost in INR/Kg or /Meter]

Section B: Physical and mechanical properties testing

1. Visual inspection and basic identification

Parameter	**Material 1**	**Material 2**	**Material 3**	**Material 4**
Appearance (colour, sheen, texture)	[Example: Dull white, rough texture]	[Example: Translucent, smooth, slightly shiny]	[Example: Transparent green, smooth]	[Example: Blue, slightly waxy feel]
Fiber Type (Continuous Filament/Staple Fibers)	[Example: Staple fibers]	[Example: Continuous filament]	[Example: Continuous filament]	[Example: Continuous filament]
Burning Test (Near Flame, In Flame, After Removal, Odor, Residue)	[Example: Burns rapidly, continues burning, afterglow, paper smell, fine ash]	[Example: Melts and burns with light flame, drops, hard bead residue]	[Example: Melts and burns, sooty black smoke, drops]	[Example: Shrinks, melts, and burns, drops]
Water Test (Float/Sink)	[Example: Sinks]	[Example: Sinks]	[Example: Sinks]	[Example: Floats]

2. Tensile strength and breaking strength

Parameter	**Material 1**	**Material 2**	**Material 3**	**Material 4**
Tensile Strength (Dry)	[Value in N/mm^2 or Kgf]	[Value in N/mm^2 or Kgf]	[Value in N/mm^2 or Kgf]	[Value in N/mm^2 or Kgf]
Tensile Strength (Wet)	[Value in N/mm^2 or Kgf]	[Value in N/mm^2 or Kgf]	[Value in N/mm^2 or Kgf]	[Value in N/mm^2 or Kgf]
Breaking Strength (Dry)	[Value in daN or Kg]	[Value in daN or Kg]	[Value in daN or Kg]	[Value in daN or Kg]

Breaking Strength (Wet)	[Value in daN or Kg]	[Value in daN or Kg]	[Value in daN or Kg]	[Value in daN or Kg]
Elongation at Break	[Value in %]	[Value in %]	[Value in %]	[Value in %]

3. Other properties

Parameter	Material 1	Material 2	Material 3	Material 4
Water Absorption	[Value in %]	[Value in %]	[Value in %]	[Value in %]
Abrasion Resistance	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]
UV Resistance/Weathering Resistance	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]
Durability (Expected Lifespan)	[Number of years]	[Number of years]	[Number of years]	[Number of years]
Buoyancy (if applicable)	[Float/Sink]	[Float/Sink]	[Float/Sink]	[Float/Sink]

Section C: Performance evaluation in fishing operations

Parameter	Material 1	Material 2	Material 3	Material 4
Ease of Handling (wet/dry)	[Rating: Easy/Medium/ Difficult]	[Rating: Easy/Medium/ Difficult]	[Rating: Easy/Medium/ Difficult]	[Rating: Easy/Medium/ Difficult]
Catch Efficiency (relative to standard net)	[Value in %]	[Value in %]	[Value in %]	[Value in %]

Damage to Fish (Scale Loss, Bruising)	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]
Bycatch Rate	[Value in %]	[Value in %]	[Value in %]	[Value in %]
Impact on Ghost Fishing/ALDFG (Abandoned, Lost, Discarded Fishing Gear)	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]	[Rating: High/Medium/Low]

Section D: Overall assessment and recommendations

1. Suitability for different fishing gear

- Gillnets: [Example: Nylon (monofilament) due to strength and ghost fishing mitigation]
- Trawl Nets: [Example: HDPE due to strength and durability]
- Cast Nets: [Example: Nylon due to ease of handling and strength]

2. Suitability for Kakinada fisheries

- Marine Fisheries: [Example: Nylon and HDPE due to their strength and durability, especially in coastal and deep-sea fishing]
- Inland Fisheries: [Example: Nylon and some natural fibers like cotton for smaller nets or specific traditional gear like push nets]

3. Considerations for sustainable fisheries

- Biodegradable Materials: Evaluate the performance and cost-effectiveness of biodegradable netting materials as an alternative to reduce plastic pollution and ghost fishing.
- Fishing Gear Marking: Explore the use of gear marking to identify lost nets and promote responsible fishing practices.
- Recycling and Reuse: Investigate opportunities for recycling end-of-life synthetic netting materials.

Recommendations:

1. Prioritize the use of synthetic materials like Nylon and HDPE for most fishing operations in Kakinada due to their superior strength, durability, and cost-effectiveness.
2. Consider the use of biodegradable netting materials for specific applications or as pilot projects to reduce the environmental impact of ghost fishing.

3. Promote the adoption of selective fishing gear and responsible fishing practices to minimize bycatch and ghost fishing.
4. Conduct regular awareness campaigns and training programs for fishermen on the importance of proper netting material selection, maintenance, and responsible disposal.

This worksheet provides a comprehensive framework for testing and evaluating different netting materials in the context of Kakinada's fisheries. The collected data and analysis will help in making informed decisions about the most suitable materials for efficient, sustainable, and environmentally responsible fishing practices in the region.

Experiment 4. Estimation of buoyancy and de-buoyancy of different floating and sinking materials

This worksheet guides students through practical exercises to estimate buoyancy (lifting force) and de-buoyancy (sinking force) of materials commonly used in fishing gear. This knowledge is essential for designing efficient and selective fishing gear. Archimedes' Principle states that buoyant force equals the weight of the fluid displaced.

Section A: Materials and equipment

- **Test Materials:**
  - **Floating materials:** Floats (various sizes, shapes, and materials - e.g., PVC, hard plastic), Synthetic netting materials (e.g., Polyethylene - PE, High-Density Polyethylene - HDPE).
  - **Sinking materials:** Sinkers (various sizes, shapes, and materials - e.g., Lead, Iron, Clay), Synthetic netting materials (e.g., Nylon - Polyamide), Natural netting materials (e.g., Cotton, Jute), Rope (different materials and diameters).
- **Measuring Equipment:**
  - Spring balance (accuracy 0.1g or 1g)
  - Measuring cylinder or Eureka can
  - Large container (e.g., bucket, tub)
  - Water (freshwater and optionally seawater)
  - Thread or thin line
  - Vernier caliper or ruler (for dimension measurements)
  - Calculator

4 a: Section B: Buoyancy estimation

Object/Material	Weight in Air (g)	Weight in Water (g) (Submerged)	Apparent Weight Loss (g) (Wa - Ww)	Volume of Water Displaced (cm^3) (Equal to Apparent	Buoyant Force (g) (Equal to Volume of Water Displaced)

				Weight Loss)	
Floats					
Float 1 (Plastic)					
Float 2 (PVC)					
Float 3 (Polystyrene)					
Floating Nets					
PE Netting Sample					
HDPE Netting Sample					

Procedure for buoyancy estimation:

1. **Measure weight in air:** Hang the object/material on a spring balance and record its weight in air (Wa).
2. **Submerge and measure weight in water:** Submerge the object/material completely in water while still suspended from the spring balance. Record the weight in water (Ww). Dr. Rajendra Prasad Central Agricultural University mentions suspending a scoop net with a weight in water and noting the initial weight of the balance to determine the lifting capacity of a float.
3. **Calculate apparent weight loss:** Subtract the weight in water from the weight in air (Wa - Ww). This represents the buoyant force acting on the object. The buoyant force on an object is equal to the weight of the fluid displaced by the object.
4. **Determine volume of water displaced:** In freshwater (density ~1 g/cm^3), the apparent weight loss in grams is approximately equal to the volume of water displaced in cm^3.
5. **Record buoyant force:** The buoyant force in grams is numerically equal to the volume of water displaced in cm^3.

4B Section C: De-buoyancy estimation

Object/Material	Weight in Air (g)	Volume (cm^3) (Measured	Density (g/cm^3)	Weight in Water (g) (Submerged)	De-buoyancy (Sinking

		or Calculated)	(Wa / Volume)		Force) (g) (Wa - Buoyant Force)
Sinkers					
Sinker 1 (Lead)					
Sinker 2 (Iron)					
Sinker 3 (Clay)					
Sinking Nets					
Nylon Netting Sample					
Cotton Netting Sample					
Rope Sample					

Procedure for de-buoyancy estimation:

1. **Measure weight in air:** Hang the object/material on a spring balance and record its weight in air (Wa).
2. **Determine volume:**

1. For regularly shaped objects (e.g., sinkers, floats): Measure dimensions (length, width, height, diameter) using a ruler or Vernier caliper and calculate the volume (e.g., V = L x W x H for rectangular blocks, $V = \pi r^2 h$ for cylinders, $V = (4/3)\ \pi r^3$ for spheres).
2. For irregularly shaped objects (e.g., netting, rope, some sinkers): Use the water displacement method with a measuring cylinder or Eureka can. Submerge the object and record the volume of water displaced. This volume is equal to the object's volume.
3. Calculate density: Divide the weight in air (Wa) by the volume.
4. Measure weight in water: Submerge the object/material completely in water while still suspended from the spring balance. Record the weight in water (Ww).
5. Calculate buoyant force: Determine the weight of water displaced (Volume of object x Density of water). In freshwater, this is numerically equal to the volume of the object in cm^3.
6. Calculate de-buoyancy (sinking force): Subtract the buoyant force from the weight in air (Wa - Buoyant Force). This represents the net downward force or the de-buoyancy. If the weight of an object is greater than the upthrust or buoyant force, it sinks.

Section D: Analysis and interpretation

1. Compare buoyancy/de-buoyancy of different materials: Analyse the results to understand how material type, density, and volume influence floating and sinking properties.

   Further Investigations:

- Repeat the experiment using seawater to compare the buoyant force.
- Investigate the effect of temperature on buoyancy.
- Test the buoyancy/de-buoyancy of different types of fishing lures and baits.

  This worksheet provides a foundation for understanding the principles of buoyancy and de-buoyancy and their practical applications in fisheries. By conducting these experiments, students gain hands-on experience and develop a deeper appreciation for the physics involved in fishing gear design and operation.

Experiment 5: Designing trawl net by conducting survey

This worksheet outlines a survey protocol to guide the design of trawl nets for the specific needs of fisheries in the Kakinada region. It incorporates ecological, biological, operational, and regulatory considerations to optimize net performance, minimize bycatch, and ensure compliance with regulations.

Section A: Survey planning and preliminary information

Parameter	Response
Date of Survey	[Date of survey]
Survey Team	[Names and roles of the survey team members]
Focus Area (e.g., Kakinada Bay, Offshore Waters)	[Specify the area for trawl operation]
Objectives of New Trawl Design	[Example: Increase selectivity for specific species, reduce bycatch, improve fuel efficiency, increase overall catch rates]
Existing Trawl Designs Used in the Area	[Example: Two-seam fish trawls, shrimp trawls, Disco Dol]
Local Regulations (Andhra Pradesh Marine Fishing Regulation Act, 1995)	[Example: Minimum mesh size of ½ inch, closed seasons (April 15 – May 31), restrictions on bottom trawling within three nautical miles of the shore]

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Section B: Trawling operations and target species

Parameter	**Details (from interviews with fishermen, logbooks, observations)**
Target Species (Fin Fish, Shrimp, Cephalopods)	[Example: Sciaenids, Threadfin breams, Silverbellies, Shrimp (*Metapenaeus dobsoni, M. monoceros, M. brevicornis, M. affinis, Penaeus indicus, P. monodon)]*
Size Range of Target Species	[Example: Small, medium, large, depending on the species]
Depth of Trawling Operations	[Example: 5 - 80 meters]
Seabed Characteristics (Muddy, Sandy, Rocky)	[Example: Primarily muddy or sandy bottom]
Season of Operation	[Example: Varies based on target species, regulated by closed seasons]
Vessel Size and Engine Power	[Example: Small mechanized boats (Pablos - 9m, Pomfrets - 10m, Sorrahs - 12m, with varying engine power)]
Towing Speed	[Example: 2-6 knots]
Average Towing Duration	[Example: 1-2 hours]

Section C: Current trawl net design and materials

Parameter	Details of Currently Used Nets
Net Type (Bottom, Midwater, Shrimp, Fish)	[Example: Bottom otter trawls, shrimp trawls]
Netting Material (e.g., Nylon, HDPE, Cotton)	[Example: HDPE (Polyethylene), Nylon (Polyamide)]
Twine Diameter	[Example: Varies depending on net section, e.g., 1.25 mm, 1.00 mm]
Mesh Size (Cod end, Body Sections)	[Example: Cod end mesh size - 25 mm, Belly sections - 800 mm to 25 mm]

Number of Seams	[Example: Two-seam, Four-seam, Six-seam]
Overall Length of Net	[Example: 27.04 to 30.86 m]
Head Rope and Foot Rope Length and Diameter	[Example: Head rope - 18 to 22m, Foot rope - 20 to 26m, Diameter - 10-12mm]
Use of Overhangs/Square Section	[Example: Square section with 800mm mesh size, 180 meshes in upper and lower edge]
Use of Otter Boards/Beam	[Example: Otter boards used for horizontal opening]
Ground Gear Type	[Example: Varies depending on seabed, may include rubber disks or bobbins to minimize abrasion]

Section D: Observed challenges and opportunities

Parameter	Observations/Feedback from Fishermen/Experts
Bycatch Composition and Quantity	[Example: Significant bycatch of juvenile fish and non-target species, necessitating sorting]
Fuel Consumption Issues	[Example: High fuel costs due to net drag]
Net Damage and Wear & Tear	[Example: Abrasion of netting on rough seabed]
Selectivity Issues (e.g., Small Fish Escaping)	[Example: Small mesh sizes lead to capture of similar-sized species to targeted shrimp]
Availability and Cost of Netting Materials	[Example: Availability of HDPE and Nylon, cost fluctuations]
Availability of Skilled Labor for Net Mending/Construction	[Example: Availability of skilled workers for net construction and repair]
Environmental Concerns (Seabed Impact, Ghost Fishing)	[Example: Concerns about habitat disturbance and lost/discarded fishing gear]
Potential for Gear Modifications (e.g., BRDs, Square Mesh Cod ends)	[Example: Potential for using BRDs or square mesh cod ends to reduce bycatch]

Interest in New Technologies (e.g., Lighter Netting Materials, Pulse Trawls)	[Example: Interest in Dyneema or Spectra netting to reduce drag, exploring pulse trawls for reduced seabed impact]

Section E: Proposed changes and design parameters for the new trawl net

Parameter	**Proposed Design Parameter/Modification**	**Rationale/Expected Benefits**
Target Species	[Example: Selective for large shrimp and specific finfish species like sciaenids]	Address issues of bycatch and overfishing of juvenile fish.
Netting Material	[Example: Combination of HDPE for main body and Dyneema/Spectra for sections requiring higher strength and reduced drag]	Reduce fuel consumption and increase net lifespan.
Twine Diameter	[Example: Optimize twine diameter based on material strength and desired drag reduction]	Reduce drag without compromising net strength.
Mesh Size (Cod end, Body Sections)	[Example: Increase cod end mesh size to reduce capture of juveniles (e.g., >25mm for prawns), adjust mesh sizes in other sections to optimize catch efficiency and selectivity]	Allow escapement of juveniles and non-target species.
Net Mouth Opening (Vertical and Horizontal)	[Example: Increase vertical opening for specific finfish, adjust horizontal spread for optimal coverage]	Improve capture efficiency for target species.
Hanging Ratio	[Example: Adjust hanging ratio to achieve desired net shape and opening characteristics]	Optimize net shape and performance in water.
Ground Gear Design	[Example: Utilize lighter ground gear or off-bottom rigging options (e.g., roller clump weights) to reduce seabed impact]	Minimize habitat disturbance and gear damage.

Incorporate Bycatch Reduction Devices (BRDs)	[Example: Include Nordmøre-grid BRDs or large mesh panels in the upper belly section]	Reduce bycatch of fish and other non-target species.
Use of Turtle Excluder Devices (TEDs)	[Example: Include TEDs in areas with significant turtle bycatch]	Facilitate the escape of turtles incidentally caught.
Use of Bird Scaring Lines (BSLs)	[Example: Implement BSLs to deter seabirds from warp cables]	Reduce seabird interactions and bycatch.
Overall Net Length	[Example: Optimize overall length to match vessel size and towing power, while considering fishing grounds]	Maximize catch efficiency and minimize operational costs.

Section F: Economic and socio-economic considerations

Parameter	**Details**
Cost of Materials (Estimated)	[Example: Increased cost of Dyneema/Spectra compared to traditional materials]
Cost of Net Construction/Assembly	[Example: Estimate labour costs for net construction/modifications]
Expected Changes in Fuel Consumption	[Example: Anticipate reduction in fuel costs due to reduced drag]
Potential Impact on Catch Rates and Composition	[Example: Expected increase in target species catch, decrease in bycatch]
Short-term and Long-term Economic Benefits for Fishermen	[Example: Short-term: potential reduction in catch (due to selectivity), increased cost of new net. Long-term: increased profitability due to higher-value catches, reduced bycatch, lower fuel consumption]
Social Acceptance of New Design	[Example: Discuss with fishermen's groups to understand their acceptance and concerns]
Impact on Employment and Livelihoods	[Example: Assess potential impact on net menders and associated industries]

Section G: Trial and evaluation plan

Parameter	Details
Experimental Design (e.g., Paired Hauls with Control)	[Example: Conduct paired hauls with the new design and a conventional trawl net as control]
Data Collection (Catch Composition, Size, Weight, Fuel Consumption)	[Example: Measure length and weight of all fish caught, record fuel consumption per haul]
Monitoring of Gear Performance (Net Opening, Door Spread)	[Example: Use acoustic sensors (e.g., Scanmar) to monitor net geometry and performance]
Evaluation of Bycatch Reduction and Selectivity	[Example: Compare bycatch rates between the new and control net, assess selectivity based on length-frequency distributions]
Assessment of Environmental Impact (Seabed Contact, Benthic Organisms)	[Example: Monitor seabed contact using cameras or sensors, assess benthic impacts if possible]
Stakeholder Feedback and Acceptance	[Example: Conduct post-trial discussions with fishermen and other stakeholders]
Duration of Trial	[Example: 2-4 weeks, depending on fishing conditions and number of hauls]

This comprehensive survey protocol provides a structured approach to design and evaluate trawl nets for the specific context of Kakinada fisheries, promoting sustainable fishing practices and improved livelihoods for the fishing community. Remember to involve local fishermen and experts from institutes like the Central Marine Fisheries Research Institute throughout the process for successful implementation.

Experiment 6. Solving problems on finding position of gravity, flotation and buoyancy

6.a. Finding position of gravity

The centre of gravity (CG) of fishing gear components like floats and sinkers plays a vital role in determining the stability and behaviour of the fishing gear in water. The centre of gravity is defined as the point at which the entire weight of a body may be considered as concentrated,

Section A: Materials and equipment

- **Test Materials:**
  - Floats (various sizes, shapes, and materials - e.g., plastic, cork, foam)

- Sinkers (various sizes, shapes, and materials - e.g., lead, iron, concrete)
- Fishing net sections incorporating floats and sinkers (e.g., a portion of a gillnet, a small trawl net section)

- **Measuring Equipment:**
    - Spring balance or electronic weighing scale (accuracy 0.1g or 1g)
    - Plumb line (string with a weight attached)
    - Ruler or measuring tape
    - Pen/marker
    - Pin/nail/hook for suspension
    - Cardboard or thin sheet (for irregularly shaped objects)
    - Pencil

Section B: Determining the centre of gravity (CG)

1. For regularly shaped objects (uniform density)

Object/Material	**Dimensions (Length, Width, Height/Diameter)**	**Calculated CG (X, Y, Z coordinates)**
Float 1 (Spherical)	Diameter: [Value] cm	Centre of the sphere
Sinker 1 (Rectangular)	Length: [Value] cm, Width: [Value] cm, Height: [Value] cm	Centre of the rectangle (Length/2, Width/2, Height/2)

Procedure for regularly shaped objects:

1. **Identify the geometric centre**: For objects with uniform density and regular shapes (sphere, cube, cylinder, rectangular prism), the centre of gravity is located at the geometric centre.
2. **Measure dimensions**: Accurately measure the dimensions (length, width, height, diameter, radius) of the object using a ruler or Vernier caliper.
3. **Determine CG coordinates**: Calculate the coordinates of the geometric centre based on the object's shape. For example, for a rectangular block, the CG would be at the midpoint of each dimension (Length/2, Width/2, Height/2).

2. For irregularly shaped objects (including floats, sinkers, and net sections)

Object/Material	**Suspension Point 1**	**Plumb Line Mark 1**	**Suspension Point 2**	**Plumb Line Mark 2**	**Suspension Point 3**	**Plumb Line Mark 3**	**Estimated CG Location (Intersection of Lines)**
Float A (Irregular)	[Point on edge]	[Line traced]	[Another point on edge]	[Line traced]	[Third point on edge]	[Line traced]	[Point of intersection]

Sinker B (Irregular)	[Point on edge]	[Line traced]	[Another point on edge]	[Line traced]	[Third point on edge]	[Line traced]	[Point of intersection]
Net Section C	[Point on edge]	[Line traced]	[Another point on edge]	[Line traced]	[Third point on edge]	[Line traced]	[Point of intersection]

Procedure for irregularly shaped objects (using the plumb line method):

1. **Prepare the object:** If the object is thin and relatively flat (like a piece of netting), you can directly use the method. For bulkier items like floats or sinkers, you may need to attach a small, thin piece of cardboard to which the plumb lines can be marked, or mark directly on the object's surface if feasible.
2. **Make suspension points**: Pierce at least three small holes or create suspension points near the edge of the object.
3. **First suspension:** Suspend the object freely from one of the suspension points using a pin, nail, or hook.
4. **Hang the plumb line**: Attach the plumb line to the same suspension point and allow both the object and the plumb line to settle.
5. **Mark the line:** Draw a line on the object along the string of the plumb line. You can use chalk or a marker.
6. **Repeat for other suspension points:** Repeat steps 3-5 for at least two other suspension points, making sure to use a different point each time and drawing a new line.
7. **Identify the centre of gravity:** The point where all the drawn lines intersect is the centre of gravity of the object.

Section C: Analysis and interpretation

1. **Compare CG location for different materials:** Discuss how the distribution of mass influences the location of the CG in different materials.
2. **Relate CG to stability of fishing gear:** Consider how the CG of floats, sinkers, and the overall net configuration affects the stability and hanging characteristics of the fishing gear in water. The Centre of Gravity (CG) is the point where an object's weight is evenly distributed in all directions and is essential for analysing stability, balance, and motion across different systems.
3. **Factors affecting CG in real-world scenarios:** Discuss how factors like fouling (growth of marine organisms on the net), wear and tear, or modifications to the gear can affect the CG and alter its performance in water.

Conclusion:

Based on the experiments, summarize the key findings regarding the centre of gravity of floats, sinkers, and net sections, and their relevance to fishing gear design and stability.

6b Flotation and buoyancy of fishing equipment

This worksheet provides a protocol for estimating the buoyancy and flotation characteristics of fishing gear components like floats, lines, and netting. Understanding these properties is crucial for proper gear design and successful fishing operations in waters.

Section A: Materials and equipment

- **Test Materials:**
    - Floats (various sizes, shapes, and materials - e.g., PVC, hard plastic, expanded foam, cork, wooden floats, thermocole, aluminium, steel, fiberglass, rubber)
    - Netting materials (e.g., Nylon (Polyamide), HDPE (Polyethylene), Cotton, Jute)
    - Ropes (various materials and diameters - e.g., Polyethylene - PE, Polyamide - PA)
    - Sinkers (various sizes and materials - e.g., lead, iron, concrete)
- **Measuring Equipment:**
    - Spring balance or electronic weighing scale (accuracy 0.1g or 1g)
    - Measuring cylinder or Eureka can
    - Large container (e.g., bucket, tub)
    - Water (freshwater and optionally seawater)
    - Thread or thin line
    - Vernier caliper or ruler (for dimension measurements)
    - Calculator

Section B: Estimating buoyancy

1. By displacement (for all objects)

Object/Material	**Weight in Air (g)**	**Weight in Water (g) (Submerged)**	**Buoyant Force (g) (Apparent Weight Loss = Wa - Ww)**	**Volume of Water Displaced (cm^3) (Equal to Buoyant Force)**
Floats				
Float 1 (Plastic)	[Example: 20]	[Example: -30 (object floats, needs to be pushed down)]	[Example: 50 (buoyant force pushes up)]	[Example: 50]
Float 2 (PVC)	[Value]	[Value]	[Value]	[Value]
Float 3 (Expanded Foam)	[Value]	[Value]	[Value]	[Value]
Floating Netting/Rope				

PE Netting Sample	[Value]	[Value]	[Value]	[Value]
HDPE Rope Sample	[Value]	[Value]	[Value]	[Value]

Procedure for buoyancy estimation (by displacement):

1. **Measure weight in air:** Hang the object/material on a spring balance and record its weight in air (Wa).
2. **Submerge and measure weight in water:** Submerge the object/material completely in water while still suspended from the spring balance. Record the weight in water (Ww).
3. **Calculate buoyant force:** Subtract the weight in water from the weight in air (Wa - Ww). This represents the buoyant force acting on the object. Archimedes' Principle states that the buoyant force on an object is equal to the weight of the fluid displaced by the object. The buoyant force (Fb) can be calculated using the equation $F_b = \rho V g$, where ρ is the density of the fluid, V is the volume of displaced fluid, and g is the acceleration due to gravity}., Study.com notes that the buoyant force on an object is equal to the weight of the fluid displaced by the object.
4. **Determine volume of water displaced:** In freshwater (density ~1 g/cm^3), the apparent weight loss in grams is approximately equal to the volume of water displaced in cm^3.
5. **Record buoyant force:** The buoyant force in grams is numerically equal to the volume of water displaced in cm^3.

2. By volume and density (for regularly shaped floating objects)

Object/Material	Dimensions (L x W x H or Diameter)	Calculated Volume (cm^3)	Density (g/cm^3) (Weight in Air / Volume)	Buoyant Force (g) (Volume x Density of Water)	Flotation Condition (Float/Sink)
Float 4 (Rectangular)	L: [Value] cm, W: [Value] cm, H: [Value] cm	[Value]	[Value]	[Value]	[Example: Float]
Float 5 (Spherical)	Diameter: [Value] cm	[Value]	[Value]	[Value]	[Value]

Procedure for buoyancy estimation (by volume and density):

1. **Measure dimensions**: Accurately measure the dimensions of the float using a ruler or Vernier caliper.
2. **Calculate volume:** Calculate the volume based on the float's shape (e.g., V = L x W x H for a rectangular block, $V = (4/3)\pi r^3$ for a sphere).
3. **Measure weight in air:** Determine the weight of the float in air (Wa).

4. **Calculate density:** Divide the weight in air by the calculated volume.
5. **Calculate buoyant force:** Multiply the volume by the density of water (e.g., 1 g/cm^3 for freshwater).
6. **Determine flotation condition:** If the buoyant force is greater than the weight of the object, it floats (positive buoyancy). If the buoyant force equals the weight, it remains suspended (neutral buoyancy). If the buoyant force is less than the weight, it sinks (negative buoyancy).

Section C: Estimating de-buoyancy (for sinking objects)

Procedure for de-buoyancy estimation:

1. **Measure weight in air:** Hang the object/material on a spring balance and record its weight in air (Wa).
2. **Determine volume:** Use the water displacement method with a measuring cylinder or Eureka can for irregularly shaped objects or calculate the volume for regularly shaped objects.
3. **Calculate density:** Divide the weight in air (Wa) by the volume.
4. **Calculate buoyant force**: Multiply the volume by the density of water.
5. **Calculate de-buoyancy** (sinking force): Subtract the buoyant force from the weight in air. This represents the net downward force.
6. **Determine flotation condition:** If the de-buoyancy is positive, the object sinks (negative buoyancy).

Section D: Analysis and interpretation

1. **Compare and contrast buoyancy and flotation:** Discuss the difference between the buoyant force acting on an object and whether the object ultimately floats or sinks (flotation condition). Buoyancy is the upward force exerted by a fluid, whereas flotation is the state of being floating.
2. **Impact of material properties:** Analyse how the density and volume of different materials affect their buoyancy and flotation characteristics. **Teachoo** highlights density of liquid and volume of solid immersed in it as the factors affecting buoyancy.
3. **Influence of water properties**: Discuss how factors like water salinity, temperature, and pressure can impact the density of water and subsequently affect the buoyancy and flotation of fishing gear. Saltwater is denser than freshwater, leading to greater buoyancy in marine environments.

Example Calculation (for a plastic float in freshwater):

- Float Type: Spherical Plastic Float
- Diameter: 10 cm
- Weight in Air (Wa): 50 g
- Weight in Water (Ww): -20 g (Float floats, needs to be pushed down)
- Buoyant Force (Wa - Ww): 50 - (-20) = 70 g
- Volume of Water Displaced: 70 cm^3
- Calculated Volume: Assuming a solid sphere, $V = (4/3)\ \pi r^3 = (4/3)\ \pi\ (5\ cm)^3 \approx 523.6\ cm^3$
- Calculated Density: $50\ g\ /\ 523.6\ cm^3 \approx 0.095\ g/cm^3$

- Flotation Condition: Since the float's density (0.095 g/cm³) is less than the density of freshwater (1 g/cm³), the float will float.

Experiment 7 Visit to fishing harbour to study deck machinery

https://www.youtube.com/watch?v=9w0XueY4oVc

For Students: Please follow the video and prepare notes

Experiment 8. Visit to fishing harbour to study hull equipment

https://www.youtube.com/watch?v=IRbuqOkMd1k

For Students: Please follow the video and prepare notes

Experiment 9. Visit to boat building yard and dry-docking yard

https://www.youtube.com/watch?v=nalNV709dTE

For Students: Please follow the video and prepare notes

Experiment 10. Visit to a fish processing unit to study the equipment used in fish processing

https://www.facebook.com/watch/?v=598742074807289

For Students: Please follow the video and prepare notes

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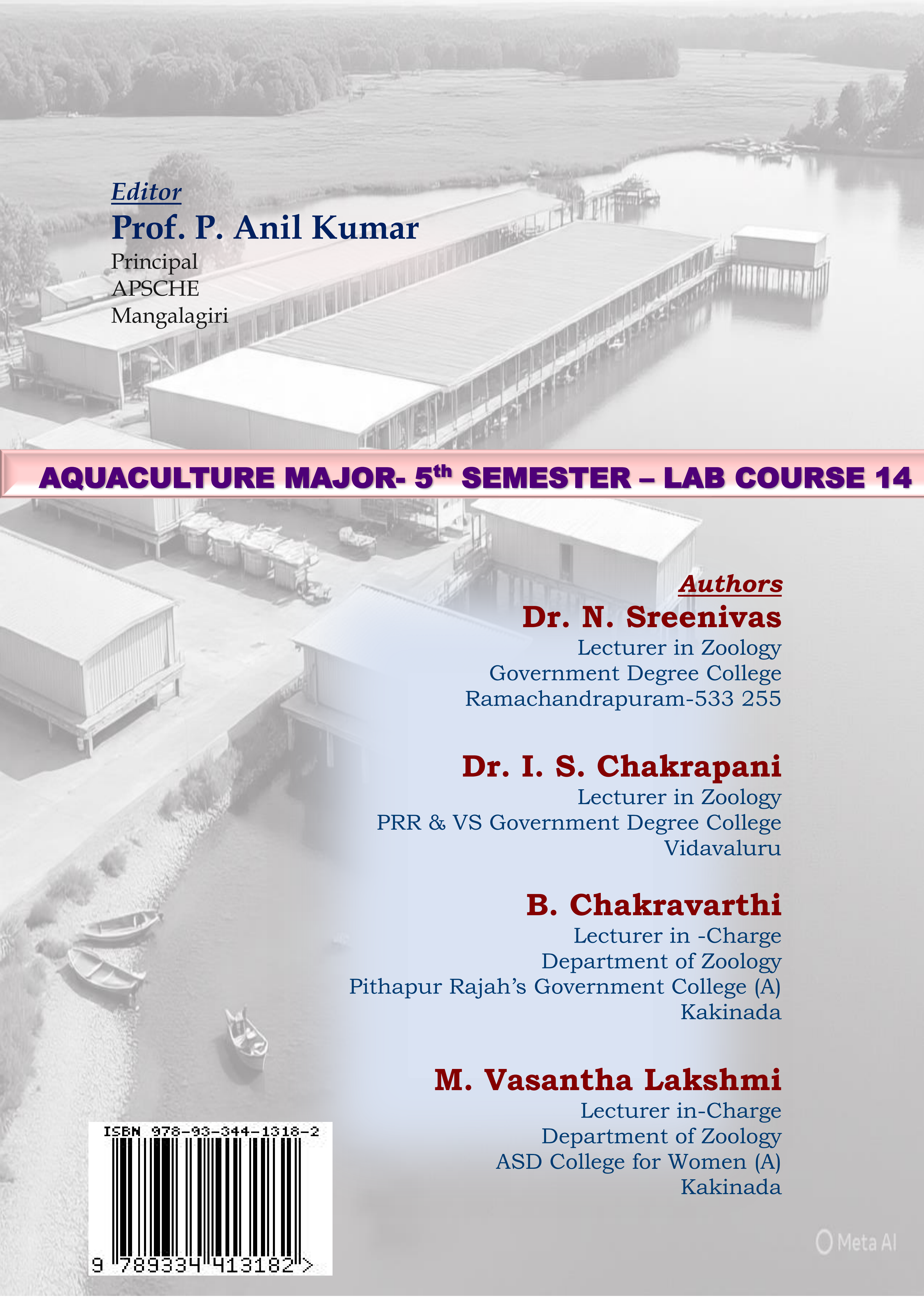

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