SNS COLLEGE OF ENGINEERING

Coimbatore-107

An Autonomous Institution

COURSE NAME : TAMILS & TECHNOLOGY

I YEAR/ II SEMESTER

UNIT –3 MANUFACTURING TECHNOLOGY

TOPIC COVERED

Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting, steel -Copper and goldCoins as source of history – Minting of Coins – Beads making-industries Stone beads -Glass beads – Terracotta beads -Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.

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TOPIC 1: Art of Ship Building:

The Tamils, especially during the Sangam period and the Chola dynasty, were known for their advanced shipbuilding technology. The ancient Tamils were master shipbuilders and skilled navigators. Their expertise in building strong, seaworthy vessels enabled them to trade, travel, and expand their influence across the Indian Ocean. Tamil ports like **Korkai**, **Poompuhar**, and **Muziris** were known for vibrant maritime activities.

1. Indigenous Shipbuilding Knowledge:

- Tamil shipbuilders had deep knowledge of hydrodynamics, wood selection, and construction techniques.
- Ships were designed for both riverine, coastal, and long-distance oceanic travel.

2.Predicting Tides:

- Tides are the regular rise and fall of sea levels caused mainly by the gravitational pull of the Moon and the Sun on the Earth's oceans. Predicting tides is crucial for navigation, fishing, coastal construction, and port operations.

Types of predicting tides by Tamils:

1. Kazhi Tide

During Kazhi tide, the sea water moves towards the shore.

2. Sea Tide

As the tide slows down, the sea water moves towards the ocean.

By observing these two tides, the people on the shore would go into the sea.

3. Materials Used:

- Wood such as:
    - Teak
    - Jackfruit
    - Indian mahogany
- Natural resins, plant-based oils, and lime were used to waterproof the hull.
- Iron tools made by Kammiyars (Tamil blacksmiths) were used in construction.

4. Harbours Used:

Front Harbour:

- The Front Harbour refers to the harbour area located near the coastline, close to residential and commercial zones.
- It was mainly used by small and medium-sized boats.
- **Functions:**
    - Domestic trade
    - Fishing boats and local travel
    - Easy access for local merchants and common people
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Big Harbour:

- The Big Harbour was built for international trade and large ocean-going ships.

  Features:

  - Facilities for loading and unloading large cargoes
  - Warehouses, wharves, and repair docks

- These harbours were usually away from residential areas and more connected to industrial and trade sectors.
- Examples of such harbours include Poompuhar's deep-sea ports used during the Chola period.

5. Types of Tamil Ships:

Name	Description
Kattumaram	Small wooden rafts (origin of "catamaran") used for fishing and local travel.
Sangaram	Twin-hulled boats used for medium-distance sea travel.
Marakkalam	Large wooden ships used for overseas trade and military.
Thoni	Inland cargo vessels used in rivers and backwaters.

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4. Role of Shipbuilding in Trade and Warfare:

- Tamil ships carried spices, textiles, pearls, and gold to Southeast Asia, Rome, and China.
- The Chola dynasty had a powerful navy built with large warships.

- Chola kings like Rajendra Chola I used their ships to invade Sri Lanka and Southeast Asia.

5. Ports and Shipyards:

- Korkai: Famous for pearl trade and ship construction.
- Poompuhar: A bustling harbor city with advanced docking(designated area to park) facilities.
- Muziris: A major Indo-Roman trade port.

6. Literary and Archaeological Evidence:

- Sangam literature (like *Pattinappalai* and *Manimekalai*) describes shipyards and trade voyages.
- Roman coins and pottery found in Tamil Nadu prove foreign sea trade.
- Underwater ruins in Poompuhar suggest submerged ancient port cities.

7. Shipbuilding Communities:

- The Kammalars (artisans) played a key role.
- Carpenters (Tatchar) and blacksmiths (Kammiyar) worked together to build ships.
- Skills were passed down through generations by oral and practical training.

8.History of Ship Building:

1. Early Shipbuilding (Ancient Period – Before 1000 BCE):

- The earliest boats were rafts and dugout canoes made from tree trunks.
- Indus Valley and Tamil traders built large wooden ships (*Paru*) for ocean trade.

2. Classical and Medieval Shipbuilding -Sangam Fleet (1000 BCE – 1500 CE):

- Chola dynasty (10th–12th century) had powerful naval fleets for trade and conquest**.**
- During the first Pandiyan Empire (550 - 950 AD), Chola Empire (850 - 1250 AD), Second Pandiyan Empire , Tamilians crossed the sea not only for business but also invaded Sri Lanka and conquered many countries in the eastern regions. During Pandiyan rule, more than 25 ports were functioning.

3. Age of Exploration and Arrival of British (15th–18th Century):

- Caravels (Portugal, Spain) and galleons improved trade and colonization.
- Dutch and British navies advanced warship design and global dominance disappeared Tamil Ship building art developed by V.O.Chidambaranar.

- In 1789, an order was passed in favour of the East India Company that no Indian carpenters, masons or blacksmiths could work on ships and imposing low rates lead to vanishing of Tamil Ship building art.

TOPIC 2:Metallurgical Studies

The science and technique of **extracting, refining, and working with metals** to produce tools, weapons, ornaments, and other artifacts. Historical evidences suggest that South India, particularly Tamil Nadu excelled in metallurgy 2500 years ago.

Tamil Nadu had expertise in iron metallurgy in the world through traditional iron handicrafts such as cattle-related iron products, metal products, bonze utensils, weapons and objects found in India.

EVIDENCE:

'Damascus Sword' famous all over the world, stands for the excellence of high organic steel made in South India. Special references to such iron objects are found in Greek, Persian and Roman Chronicles. These references date back to the first Century.

On the high technological techniques used in tin and bronze metallurgy in the Iron Age at Adhichanallur, Professor Saratha Srinivasan has scientifically explained. These metallurgical field evidences, not housed in the Chennai Museum are considered to be among the best specimens ever found in the metallurgical excavations.

(Investigating the methods of Alloy Formation):

By examining these metallic objects with an electron microscope, the properties of the metals are known and the technology involved in the formation is known.

Beta Bronze

This type of bronze is east at high temperature. It is called ‘Beta Bronze'. In metallurgy, the 'intermetallic compound' state between two metals is known as the 'Beta State'.

This Beta Bronze is cast with copper and silver at very high temperature. Among these, especially the highest grade Beta Bronze made with 23% silver has greater strength.

(Fabrication of Cast Steel by Carbon Sintering)

Carbon Sintering is a technology in which ferrous alloys are heated above their melting point and combined with organic matter (carbon).

Wood Steel

Wood steel is cast steel made by mixing iron with organic materials (iron + charcoal + glass) and heating it for several hours at temperature not less than 1400 degrees. This process is called

Carbonisation. Widely known worldwide, this superior organic wood steel is developed in South India. It is also said that this word 'Utsu' was derived from the word 'Uruku' and was changed to 'Uku' and became 'Utsu'.

TOPIC 3:Iron and Steel Industry during Sangam Age

During the **Sangam Age** (approximately 300 BCE – 300 CE), the **iron and steel industry** in South India was quite advanced for its time.

Iron and steel industry in India is one of the most important industries within the country. Evidence of the use of iron especially during the Sangam period has been found by Archaeological researchers.

1. Advanced Metallurgy

- **High-quality steel production**: South India, particularly the Tamil region, was known for producing **Wootz steel**, a high-grade steel famed for its durability and sharpness. This steel was later exported to the Middle East and Europe, where it was known as **Damascus steel**.
- Wootz steel was made through a process of smelting iron with carbon in closed crucibles, an early and sophisticated technique.

2. Centers of Production

- Regions like **Salem**, **Madurai**, and areas around the **Western Ghats** were known for iron ore and steel production.
- The abundance of iron ore and availability of hardwood (used for charcoal) made the region suitable for iron smelting.

3. Economic Significance

- Steel was a major **export commodity**. Roman records mention South Indian steel as a prized import.
- It contributed to the **international trade networks** of the time, connecting South India with the Roman Empire, the Middle East, and Southeast Asia.

4. Tools and Weapons

- The steel was used to make **agricultural tools**, **weapons**, and **implements** for daily use.
- Sangam literature describes warriors with **swords and spears** made of fine steel.

5. Literary References

- **Sangam texts** like *Purananuru* and *Akananuru* mention iron weapons and blacksmiths, indicating the cultural and economic importance of metallurgy.
- The word **"Ayanar"** is sometimes associated with protectors of the village who wielded iron weapons, indicating its role in society.

Extraction of Iron:

Extracting iron from iron ore is more difficult than extracting copper or tin from copper or silver ore. The process of iron extraction appears to have been invented by the Indian Civilizations during the Iron Age around 1200 BC.

The history of the development of iron metallurgy can be traced back to various past cultural civilizations. Iron is known to have been used in various civilizations including Iran, Egypt, Nubia, Europe, China and Japan.

Products Made in Iron Factory

By the early 13th Century BC, iron smelting was practised on a large scale in India. It suggests that the technology might have originated as early as the 16th Century BC.

Evidence - Radio Carbon Datins

Some of the earliest iron objects found in India have been proven to be earlier than 1400 BC by Radio Carbon Dating Method.

Spikes, knives, daggers, arrow heads, bowls, spoons, vessels, axes, chisels, door fittings, etc., dating from 600 BCE to 200 BCE have been found at many archaeological sites. All these were probably made in iron in 12th Century BC or 11th Century BC.

1. Gold

Gold is the most ancient metal used in human history. It is not affected by conditions and does not react with other chemicals. So, it is found in nature in its unique elemental stale.

Elements such as silver, copper, zinc and iron are found to used to a certain extent in the early cultures.

2.Egyptian weapons

It is made from meteorite derived iron around 3000 BC were celebrated as knives from heaven. The first evidence of metal extraction production dates back to the 5th and 6th Centuries BC.

3.Copper

Evidence of copper separation has been found at Belovoth site. The copper found here belongs to the Kodalinga Civilization and is known to date back to 5500 BC.

4. Bronze Age

Discreet metals were known to have been discovered in the 3500 BCs. The fusion of copper and silver to create bronze, a protective metal sparked a major cultural change. This period is called Bronze Age.

Iron Industry in the Medieval Years:

• Tamilians made weapons like swords and spears smelting iron and exported them to foreign county.

• The world's first iron pillar was the Iron Pillar of erected during the reign of Chandragupta Vikramadhthiyan (375-413).

• Swords made in Indian worships are mentioned in the writings of Muhammad al-Quadrisi.

• Indian knives made of Damascus Steel entered Persja.

• During the 14th Century, European scholars studied Indian casting and metallurgical technology.

• During the reign of Mughal Emperor Akbar (1556-1605) excellent small guns were produced using the Indian metallurgical principles.

3.4 SMELT1NG IRON

Tamilians had widespread access to the technology of extracting and tooling iron from the natural sources. They might have smelted iron and made weapons.

Flint Pipes

The existence of iron smelters is further confirmed by the presence of flint pipes in places where iron waste is found. These pipes might have been used for smelting iron or blowing air through the pipe to keep the fire continuously burning.

Chennakuzhi Fire Furnace :

Chennakuzhi is a combination of the word 'Chenth' that refers to the colour characteristic of red or red fire and the ‘na’ refers to flame of fire and ‘Kuzhi’ refers to name of the place.

Chen + na + pit - 'red pit'

By being so called, we can realize that it functioned as an iron mill and lead to confirmation on existence of iron ore plant during the Sangam period.

Large circular pots of clay were probably used for smelting iron. Such pits are found wherever iron scraps are available. These were also called 'Chennakuzhigal'.

Secondary Casting Plants J

About 200 metres away from the Porpanai Fort, the secondary casitng furnaces had been operating. The raw material redstones are not f o u n d here. So, these secondary raw materials required for the plant should have been obtained from the primary metal preparation plant itself.

The carbon iron alloy thus obtained is melted in flint iron pots.Then it is poured into flint casting pipes to form the basic structure of long rod-like iron.

TOPIC 4:COPPER AND GOLD COINS AND HISTORICAL EVIDENCES

Coin is 'unit of exchange' for exchanging goods and services. Money is a medium of exchange and currency is a form of money. Coins of Moo vender stamps issued during the Sangam period

and coins of Pandyan Kings like Peruvaluthi Coins and Chezhiyan coins are the major contributors. The history and economy of Tamil Nadu can be learned through the coins issued by Moovender regional kings and the Indian economic imbalances can be seen through the coins of other country kings found in Tamil Nadu.

Metals used for Coins

The kings coined gold, silver, bronze, iron and copper to suit their economic status. Coins of the era of Rajarajan are the most available ancient coins in Tamil Nadu. Roman copper coins have been found as far back as the 1st Century BC.

Brahmi Characters on Coins)

Coins of gold, silver and copper used during the Sangam period are found with Brahmi characters such as Thinnan, Ethiran and Senthan. We can know about Senthan in the Agananooru song.

Miscellaneous Coin:

1. Stamp Coins:

Stamp coins were in use from the 5th Century BC to the 2nd

Century BC. Pandyas were the first to issue stamp coins.

2.Pandiya Coins:

Pandiyas issued copper coins followed by stamp coins. This copper coin is square shaped. In the front part, there is a horse standing to left, under whose are tortoises in two tanks. There is a fish in the background. The name Peruvazhuthi is inscribed in the form of a Tamil-Brahmi line.

3.Peruvazhuthi Coins:

The Peruvazhuthi coin is a copper coin issued by Pandiyan Kings of the Sangam period of which the pandiya title Peruvazhuthi is inscribed in these coins and shows that they are 2300 years old.

4.Chola Coins:

The Chola coins of the Sangam period have a standing on the obverse and a tiger drawn with lines on the reverse. They are made of oblong square shaped copper cast. This coin include both casting method and stamping method. It was around the 3rd Century.

5.Chera Coins:

The Chera coins of the Sangam era are found to be inscribed with bow and some coins have king's head and his name engraved on them.

6.Malayaman Coins:

Thirukovilur Malayaman, a regional king lived between 100 - 300. In the coins issued by them, Thirukovilur, the region they ruled, a river, three mountains and a road are seen.

7. Punch Coins

Punch-marked coins made of silver and copper became standard form of coinage. These punched coins are either square or round or rectangular shape.

The symbols on these were struck using punches and printing. A punch-marked coin weighs about 52 grains

8. Coins of Mauriyas

Historical evidences from the Sangam period suggest that they used silver and copper coins with punch marks.

9.coins **of** the Indo-Greeks

These coins were issued between 2nd and 1st Century BC. Mostly they are made of silver. Usually, some are rectangular and circular in shapes. They also have the name of the ruler who depicts the **puranas.** The language in it is Prakrit and the script in Karoshti.

10. Kushana Type Coins

The Kushanas were the first dynasty to issue a large number of gold coins in the 1st and 4th Centuries. Low value was found in copper coins. The coins had the image and name on the obverse and deities on the reverse. The language used is Greek.

11. The coins of the Guptas

The Guptas issued well-minted gold coins. At the top, t. I

kings are found in various guises. Some coins show playing.

TOPIC 5:Forms of Beads

Excavations have found numerous beads and coral stones Tamil Nadu in cut, ready to drill and polished condition. Therefore several evidences confirm that there must have been various

making factories during the Sangam Period.

On examining the beads found in sand, it seems that the beads have been made in the following four forms.

- Circular shape
- Barrel shape
- Biconic shape
- Spherical shape

Types of Beads:

1. Sea blue green beads

2. Gomedakam

3. Redstone

4. Purple stone

5. Manickam

6. Sapphire

7. Marble

8. Crystal stone

FLINT BEADS (OR) TERRACOTTA BEADS

The most ancient art form of mankind is flint figurines. This art appeared before the casting of art forms in stone, wood, ivory, metal, etc., These fling figures don't require greater technology or better tools to make them. The fingers are the tool. Sangam man curved the tools he used to hunt for food in stone. He then painted s thoughts as paintings on rocks. Then he made figures out of clay.

Process:

Clay or Silt is added with water to make beautiful shapes.Then it is put in kiln at suited temperature and it is allowed to harden. By this method Red, Orange and Saffron flint objects, tiles, bricks and flower pots were made.

Flint beads are made in the following steps:

- Required amount of clay is taken and it is mixed with little water.
- For making beads, a small ball of clay is taken and it is placed on the bottom of the palm and it is rolled. This will bring the correct round shape.
- With a toothpick or with an individual stick from the broomstick a hole is made in the middle. That is, the stick should be moved up and down without pressing.
- By doing like this, the hole of the bead should be made perfect.
- In this way, beads can be made in required shapes like round, cylindrical, etc., They should be dried for the whole day.
- Then, the dried beads are kept in the kiln and baked for hardening the images

SHELL BEADS or CONCH BEADS:

Conch jewelry is made from sea shells. Conch jewellery is a type of shell craft and popular is necklace. They are made up of a large number of beads. Each bead is the entire shell of a small sea snail. A wide variety of conch jewellery including bangles, ear rings are produced. The bead work is found more in them.

All conch jewellery is not made from the whole shells. Some types are made from shell parts. Conch jewellery is often found in tropical coastal locations. There, they are given to tourists as clothes or mementos.

CONCH BEADS DURING SANGAM AGE:

The oldest known jewellery in the world consists of two perforated beads made from sea snail shells. These beads were found in Skul, Israel. Also, these have recently been dated **1,35,000** years ago.

A pair of beads made from Nassarius sea snail shells around 1,00,000 years ago represents some of the earliest forms of jewellery. Bead work is the art or craft of making objects with beads.

The beads can be woven together with a special thread. Thread can be tied to a soft flexible wire or can be stuck to a surface.