2007-2020
Previous Year
Solved Papers

SSC-JE

Staff Selection Commission

Junior Engineer

Mechanical Engineering

Conventional Solved Paper

Also Useful for :

State Engineering Service Examinations & Other Competitive Examinations.

ENGINEERS ACADEMY®
Your GATEway to Professional Excellence
IES • GATE • PSUs • JTO • IAS • NET

www.eapublications.org

Published by

ENGINEERS ACADEMY®
Your GATEway to Professional Excellence
IES • GATE • PSUs • JTO • IAS • NET

Corporate Office: # 100-102, Ram Nagar, Bambala Puliya, Toll Tax,
Tonk Road, Pratap Nagar, Jaipur (Rajasthan)-302033
E-Mail : engineers.academy.india@gmail.com
Website : www.engineersacademy.org
Helpline Number : +91 8094441777

ISBN : 978-93-89149-33-3

First Edition	:	**2015**
Second Edition	:	**2016**
Third Edition	:	**2017**
Fourth Edition	:	**2018**
Fifth Edition	:	**2020**
Sixth Edition	:	**2022**

Price : ₹600.00

CONTENTS

PAPER 1

Exam Held 2007

Staff Selection Commission

Junior Engineer

SSC : JEn Conventional Paper

1. (a) Describe about Francis turbine with respect to its component parts, construction and operation. [SSC JEn : 20 Marks]

Solution :

Francis Turbine

Illustrates a Francis turbine which is a mixed flow type of reaction turbine. It is named in honour of James B. Francis (1815-92), an American Engineer, who was the first to develop an inward radial flow type of reaction turbine in 1849. Later on it was modified and the modern Francis turbine is a mixed flow type, in which water enters the runner radially at its outer periphery and leaves axially at its centre.

The water from the penstock enters a scroll casing (also called spiral casing) which completely surrounds the runner. The purpose of the casing is to provide and even distribution of water around the distributed. In order to keep the velocity of water constant throughout its path around the runner, the cross-sectional area of the casing is gradually decreased. The casing is made of a cast steel, plate steel, concrete or concrete and steel depending upon the pressure to which it is subjected. Out of these a plate steel scroll casing is commonly provided for turbines operating under 30 m or higher heads.

From the scroll casing the water passes through a speed ring or stay ring. The speed ring consists of an upper and a lower ring held together by series of fixed vanes called stay vanes. The number of stay vanes is usually taken as half the number of guide vanes. The speed ring has two functions to perform. It directs the water from the scroll casing to the guide vanes or wicket gates. Further it resists the load imposed upon it by the internal pressure of water and the weight of the turbine and the electrical generator and transmits the same to the foundation. The speed ring may be either of cast iron or cast steel or fabricated steel.

From the speed ring the water passes through a series of guide vanes or wicket gates provided all around the periphery of the turbine runner. The function of guide vanes is to regulate the quantity of water supplied to the runner and to direct water on the runner at an angle appropriate to the design. The guide vane is provided with two stems, the upper stem passes through the head cover and the lower stem seats in a bottom ring. By a system of levers and links, all the guide vanes may be turned about their stems, so as to alter the width of the passage between the adjacent guide vanes, thereby allowing a varibale quantity of water to strike the runner. the guide vanes are operated either by means of a wheel quantity of water to strike the runner. The guide vanes are operated either by means of a wheel (for very small units) or automatically by a governor.

The main purpose of the various component so far described is to lead the water to the runner with a minimum loss of energy. The runner of a Francis turbine consists of a series of a curved vanes (about 16 to 24 in number) evenly arranged around the circumference in the annular space between two plates. The vanes are so shaped that water enters the runner radially at the outer periphery and leaves it axially at the inner periphery. The change in the direction of flow of water, from radial to axial, as it passes through the runner, produces a circumferential force on the runner which, from radial to axial, as it passes through the runner, produces a circumferential force on the runner which makes the runner to rotate and thus contributes to the useful output of the runner. The runners are usually made up of cast iron, cast steel, mild steel or stainless steel. Often instead of making the complete runner of stainless steel, only those portions of the runner blades, which may be subjected to cavitation erosion, are made of stainless steel. This reduces the cost of the runner and at the same time ensures the operation of the runner with a minimum amount of maintenance. The runner is keyed to a shaft which is usually of forged steel. The torque produced by the runner is transmitted to the generator through the shaft which is usually connected to the generator shaft by a bolted flange connection.

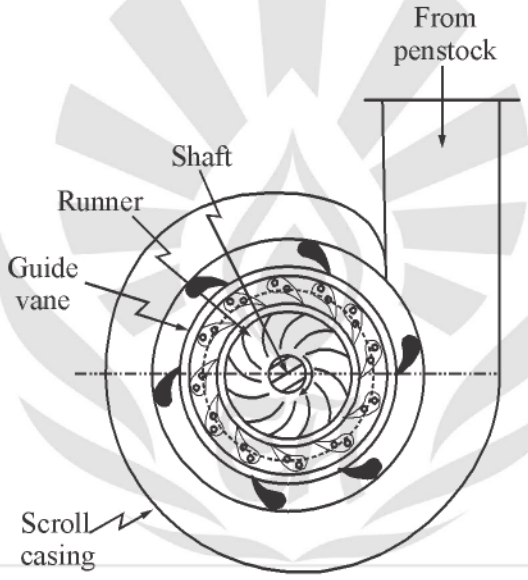
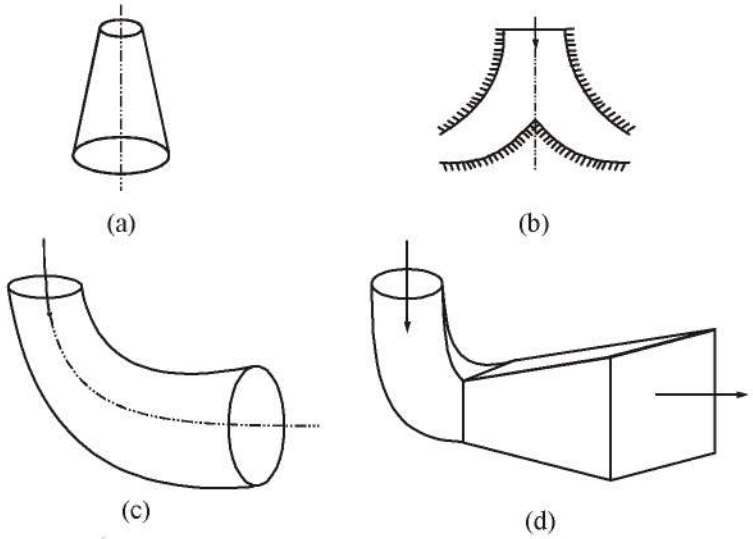


Figure : Sectional arrangement of Francis turbine

The water after passing though the runner flows to the tail race through a draft tube. A draft tube is a pipe or passage of gradually increasing crosssectional area which connects the runner exit to the tail race. It may be made of cast or plate steel or concrete. It must be airtight and under all conditions of operation its lower end must be submerged below the level of water in the tail race. The draft tube has two purposes as follows :

(i) It permits a negative or suction head to be established at the runner exit, thus making it possible to install the turbine above the tail race level without loss of head.

(ii) It converts a large proportion of velocity energy rejected from the runner into useful pressure energy i.e., it acts as a recuperator of pressure energy.



(a) Straight divergent tube
(b) Moody spreading tube (or hydraucone tube)
(c) Simple elbow tube
(d) Elbow tube Having circular cross section at inlet and rectangular at outle

Figure : Different types of draft tubes

The different types of draft tubes which are employed in the field to suit particular conditions of installation. Of these the types (a) and (b) are the most efficient, but the types (c) and (d) have an advantage that they require lesser excavation for their installation. It has been observed that for straight divergent type draft tube the central cone angle should not be more than 8°. This is so because if this angle is more than 8° the water flowing through the draft tube will not remain in contact with its inner surface, with the result that eddies are formed and the efficiency of the draft tube is reduced.

1. (b) Establish the ratio of forces exerted by a water jet when it is made to strike.

(i) a stationary flat plate held normal to it.

(ii) a flat plate moving in the direction of jet at one-third the velocity of jet.

(iii) a series of flat plates mounted on a wheel and moving at one third the velocity of jet.

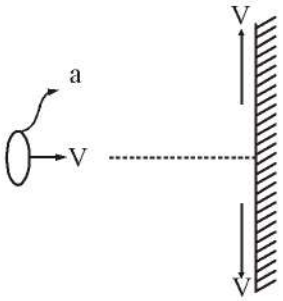
[SSC JEn : 10 Marks]

Solution :

(i)

$$\dot{m} = \rho a v$$

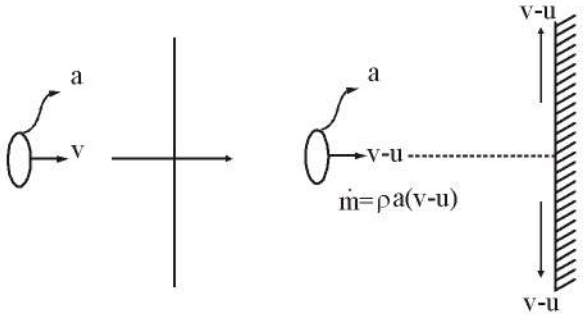
$$F = \dot{m}(V - 0)$$



$$= \rho a v \times v$$

$$= \rho a V^2$$

(ii) $F = \rho a(v - u)\,[(v - u) - 0]$

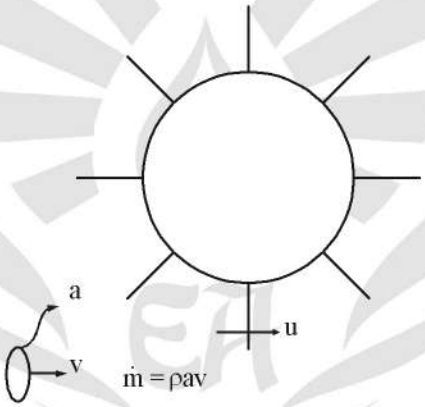


$$F = \rho a(v - u)^2$$

Given $u = \frac{v}{3}$

$\Rightarrow$ $$f = \rho a\left(v - \frac{v}{3}\right)^2 = \frac{4}{9}\rho a v^2$$

(iii) $F = \dot{m}\left[(v - u) - 0\right]$



$$F = \rho av(v - u)$$

Given $u = \frac{v}{3}$

$$F = \frac{2}{3}\rho a v^2$$

2. (a) Make a comparison of Otto, Diesel and Dual combustion cycle for

(i) maximum compression ratio and same heat input

(ii) constant maximum pressure and same heat input

(iii) same maximum temperature and pressure. **[SSC JEn : 20 Marks]**

Solution :

Comparison of Otto, diesel and dual combustion cycles

(i) For same compression ratio and same heat input : It is seen that adding the heat at constant volume (otto cycle) results in the highest maximum temperatures and pressures. Adding the same quantity

of heat at constant pressure (diesel cycle) results in the lowest maximum tempeatures and pressures while the values for the limited-pressure cycle lie between the two. The Otto cycle has the largest work area and highest efficiency. The diesel cycle has the least efficiency, the limited-pressure cycle having efficiency between the two.

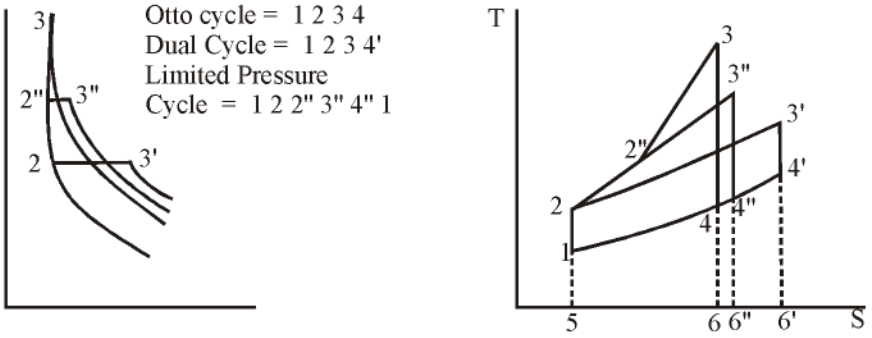


Fig. : Otto, Diesel and limited-pressure cycle with the same compression ratio and same heat input.

(ii) For constant maximum pressure and same heat input : The heat rejected by diesel cycle (area 4'-1-5-6') is less than the heat rejected by Otto cycle (area 4-1-5-6); hence the Diesel cycle is more efficient than the Otto cycle for the condition of same maximum pressure and heat input. Limited-cycle efficiency falls between the Otto and Diesel cycle.

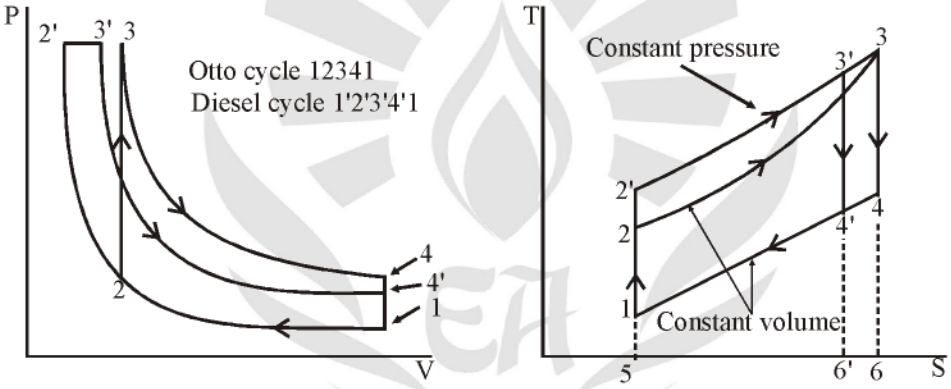


Fig. : Otto and Diesel cycle with the same maximum pressure and same heat input.

(iii) For same maximum pressure and temperature : The heat rejected by both Otto and diesel cycles is same (area 4-1-5-6 on T-s diagram) but the heat supplied to diesel cycle (area 2'-3-6-5 on T-s diagram is more than that of the Otto cycle (area 2-3-6-5 on T-s diagram).

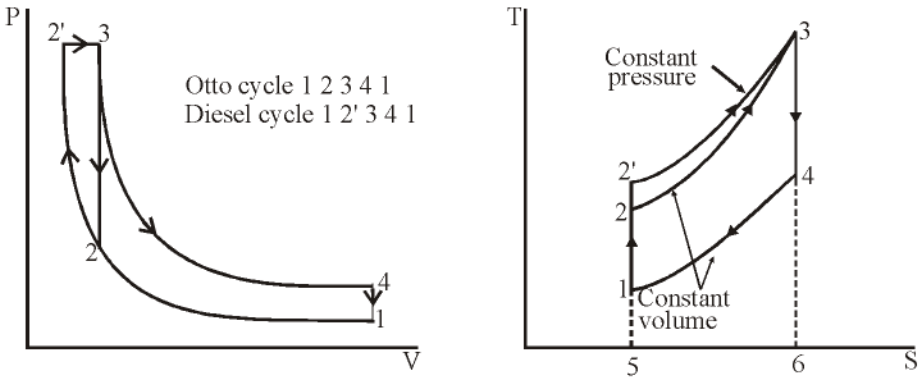


Fig. : Otto and diesel cycles with the same maximum pressure and temperature

$$\eta = 1 - \frac{\text{heat rejected}}{\text{heat supplied}}$$

Hence for these conditions diesel cycle is more efficient than Otto cycle.

(iv) For same maximum pressure and output : The efficiency is given by

$$\eta = \frac{\text{work done}}{\text{heat supplied}} = \frac{\text{work done}}{\text{work} + \text{heat rejected}}$$

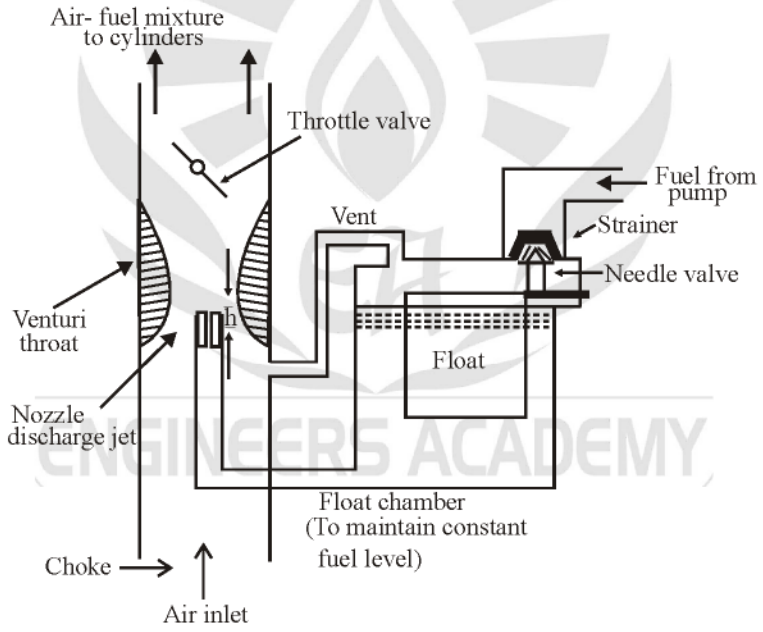
The heat rejected by the diesel cycle is less than that of Otto cycle. Hence, for these conditions, diesel cycle is more efficient than Otto cycle.

2. (b) Explain the function and working of a simple carburettor with a neat sketch.

[SSC JEn : 10 Marks]

Solution :

A simple or elementary carburettor : A simple or elementary carburettor provides an air-fuel mixture for cruising or normal range at a single speed and then to add it other mechanisms to provide for other duties like starting, idling, variable load and speed operation and acceleration.



It consists of a float chamber, nozzle with metering orifice, venturi and throttle valve. The float and a needle valve system maintains a constant height of petrol in the float chamber. If the amount of fuel in the float chamber falls below the designed level, the float lowers, thereby opening the needle of fuel supply valve. When the designed level has been reached, the float closes the needle valve, thus stopping additional fuel flow from the supply system. Float chamber is vented to the atmosphere.

Venturi is a tube of decreasing cross-section which reaches a minimum at the throat (Venturi tube is also known as choke tube and is so shaped that it gives minimum resistance to air flow). The air passing

through the venturi increases in velocity and the pressure in the venturi throat decreases. From the float chamber, the fuel is fed to a discharge jet, the tip of which is located in the throat of the venturi.

The petrol engine is quantity governed which means that when less power is required at a particular speed the amount of charge delivered to the cylinder is reduced. This is achieved by means of a throttle valve of the butterfly type which is situated after venturi tube. As the throttle is closed less air flows through the venturi tube and less is the quantity of air-fuel mixture delivered to the cylinders and hence less is the power developed. As the throttle is opened, more air flows through the choke tube, and the power of the engine increases.

A simple carburettor of the type described above suffers from a fundamental fault in that it provides increasing richness as the engine speed and air flow increases with full throttle because the density of the air tends to decrease as the rate of air flow increases.

3. (a) What are the advantages of using taper turning attachment in lathe?

[SSC JEn : 5 Marks]

Solution :

Advantages of using a lathe taper turning attachment

1. Outside and inside threads can be formed on tapered surface of work-piece.
2. Position of the centers is not distressed.
3. Accessory can be left : at set position.
4. Narrow boring may be done.
5. short taper can easily be made

3. (b) Explain cutting speed, feed and depth of cut in case of lathe.

[SSC JEn : 10 Marks]

Solution :

The cutting speed of a tool bit is defined as the number of feet of workpiece surface, measured at the circumference, that passes the tool passes the tool bit in one minute. The cutting speed, expressed in RPM, must not be confused with the spindle speed of the lathe which is expressed in RPM. to obtain uniform cutting speed the lathe spindle must be revolved faster for workplaces of small diameter and slower for workplaces of large diameter. The proper cutting speed for a given job depends upon the hardness of the material being machined, the material of the tool bit, and how much feed and depth of cut is required. Cutting speeds for metal are usually expressed in surface feet per minute, measured on the circumference of the work.

Cutting speed is define as the speed at which the work moves with respect to the tool (usually measured in meter/minute). Cutting speed can also be treated as diference in velocity (relative velocity) between the cutting tool and the work piece it is operating on.

Conventional Practice Paper

Full Mock Test Paper-1

1. (a) What are the limitations of First law of thermodynamics? **[20 Marks]**

(b) Carbon dioxide passing through a heat exchanger at a rate of 50 kg/hr is to be cooled down from 800°C to 50°C. Determine the rate of heat removal assuming flow of gas to be of steady and constant Pressure type?

Take c_p = 1.08 kJ/kg K. **[20 Marks]**

(c) Calculate the change in entropy of air, if it is throttled from 5 bar, 27°C to 2 bar adiabatically. **[20 Marks]**

2. (a) A U-tube mercury manometer with one arm open to atmosphere is used to measure pressure in a steam pipe. The level of mercury in open arm is 97.5 mm greater than that in the arm connected to the pipe. Some of steam in the pipe condenses in the manometer arm connected to the pipe. The height of this column is 34 mm. The atmospheric pressure is 760 mm of Hg. Find the absolute pressure of steam. **[30 Marks]**

(b) What is the cavitation in hydraulic turbine? Define with formula. **[30 Marks]**

(c) Draw the phase diagram on p-v coordinates for a substance which shrinks in volume on melting. Explain the relevant constant property lines. **[10 Marks]**

3. (a) Define shielded metal Arc welding? **[30 Marks]**

(b) Define hot working and its effect of Mechanical Properties of metals. **[30 Marks]**

4. (a) A steel bar 2.4 m long and 30 mm square is elongated by a load of 500 kN. If Poisson's ratio is 0.25, find the increase in volume. Take E = 0.2 × 10^6 N/mm^2. **[18 Marks]**

(b) A single plate clutch, with both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point in the contact surface is not to exceed 0.1 N/mm^2. If the coefficient of friction is 0.3, determine the power transmitted by a clutch at a speed 2500 r.p.m . **[30 Marks]**

(c) Write down the short notes on the following?

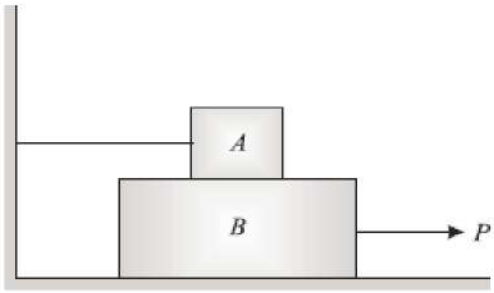
(i) Brazing

(ii) Diffusion wear in Tool

(iii) Bite angle in forging

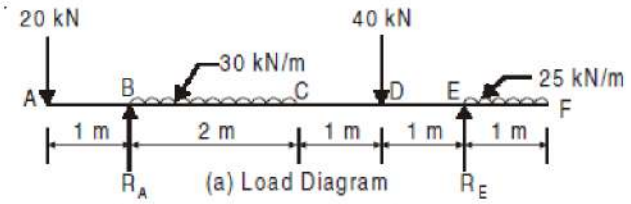
[12 Marks]

5. (a) Block A weighing 1000 N rests over block B which weighs 2000 N as shown in fig.(a). Block A is tied to a wall with a horizontal string. If the coefficient of friction between A and B is 1/4 and that between B and the floor is 1/3, what value of force P is required to create impending motion if P is horizontal ?



[15 Marks]

5. (b) Draw BM and SF diagrams for the beam shown in Fig., indicating the values at all salient points?



[30 Marks]

(c) With the help of figure explain centerless grinding process.

[15 Marks]

6. (a) A circular bar of simply supported span 1 m has to carry a central concentrated load of 800 N. Find the diameter of the bar required, if permissible stress is 150 N/mm^2.

[10 Marks]

(b) Power is transmitted using a V-belt drive. The included angle of V-groove is 30°. The belt is 20 mm deep and maximum width is 20 mm. If the mass of the belt is 0.35 kg per metre length and maximum allowable stress is 1.4 MPa, determine the maximum power transmitted when the angle of lap is 140°. $\mu = 0.15$. **[20 Marks]**

6. (c) Explain different types of patterns used in foundry. **[30 Marks]**

❑❑❑