

1008276

SJE 2018

GENERAL ENGINEERING / सामान्य इंजीनियरी  
PAPER II / प्रश्न-पत्र II

Time allowed : 2 Hours

निर्धारित समय : दो घण्टे

Maximum Marks : 300

अधिकतम अंक : 300

## Attention :

1. The paper consists of **Part A** (Civil and Structural) and **Part B** (Electrical) and **Part C** (Mechanical) and **only one Part** is to be attempted as per option given in the Application Form. Candidates should attempt **5 questions in all**. All questions carry **equal marks**.
2. Each candidate will be given **one Answer Book**.
3. Answers to all questions must be written in one language, i.e., either in English or in Hindi according to the option given by the candidate in his/her Application Form. Candidates are **not allowed** to write the answers partly in English and partly in Hindi.
4. Candidates must write their Roll No., Ticket No., Name of the Examination and Subject at the prescribed place on the cover page of the Answer Book correctly. Candidates must also put their signature, and left-hand thumb impression on the cover page at the prescribed place. The above instructions must be fully complied with failing which the Answer Book will not be evaluated and zero mark will be awarded.
5. No credit will be given for answers written in a language other than the one opted by the candidate.
6. Necessary tables of IS 456 : 2000 Code of Practice are given at the end of Part A for use of candidates attempting Civil and Structural part.
7. "Mobile phones and wireless communication devices are completely banned in the examination halls/rooms. Candidates are strictly advised not to keep mobile phones/any other wireless communication devices with them, even switching it off, in their own interest. Failing to comply with this provision will be considered as using unfair means in the examination and action will be taken against them including cancellation of their candidature and debarement from the examination of the Commission as per provisions of the notice of examination."

## ध्यान दीजिए :

1. प्रश्न-पत्र में भाग क (सिविल एवं संरचनात्मक) और भाग ख (विद्युत) एवं भाग ग (यांत्रिक) हैं और आवेदन-पत्र में दिए गए विकल्प के अनुसार केवल एक भाग का ही उत्तर दिया जाना है। अभ्यर्थियों को कुल पाँच प्रश्नों का उत्तर देना है। सभी प्रश्नों के अंक बराबर हैं।
2. प्रत्येक अभ्यर्थी को एक उत्तर-पुस्तिका दी जाएगी।
3. सभी प्रश्नों के उत्तर अभ्यर्थी द्वारा अपने आवेदन-पत्र में दिए गए विकल्प के अनुसार किसी एक भाषा में अर्थात् अंग्रेजी या हिन्दी में, दिए जाने चाहिए। अभ्यर्थियों को कुछ उत्तर अंग्रेजी में और कुछ उत्तर हिन्दी में लिखने की अनुमति नहीं है।
4. अभ्यर्थी उत्तर-पुस्तिका के आवरण पृष्ठ पर निर्धारित स्थान में अपना रोल नंबर, टिकट नंबर, परीक्षा का नाम तथा विषय सही-सही अवश्य लिखें। अभ्यर्थी आवरण पृष्ठ पर निर्धारित स्थान में अपने हस्ताक्षर एवं बाएँ हाथ के अंगूठे का निशान भी अवश्य लगाएँ। उपर्युक्त अनुदेशों का पूरी तरह अनुपालन किया जाए, अन्यथा उत्तर-पुस्तिका को नहीं जाँचा जाएगा और शून्य अंक दे दिया जाएगा।
5. अभ्यर्थी द्वारा दिए गए विकल्प की भाषा के अतिरिक्त किसी अन्य भाषा में दिए गए उत्तरों के लिए कोई अंक नहीं दिए जाएँगे।
6. सिविल एवं संरचनात्मक भाग की परीक्षा देने वाले अभ्यर्थियों के प्रयोग के लिए आई.एस. 456 : 2000 प्रेक्टिस कोड की आवश्यक सारणियाँ भाग क के अन्त में दी गई हैं।
7. "परीक्षा हॉलों/कमरों में मोबाइल फोन तथा बेतार संचार साधन पूरी तरह निषिद्ध हैं। अभ्यर्थियों को सख्तीपूर्वक उनके अपने हित में सलाह दी जाती है कि मोबाइल फोन/किसी अन्य बेतार संचार साधन को स्विच ऑफ करके भी अपने पास न रखें। इस प्रावधान का अनुपालन न करने को परीक्षा में अनुचित उपायों का प्रयोग माना जाएगा और उनके विरुद्ध कार्रवाई की जाएगी, जिसमें उनकी अभ्यर्थिता को निरस्त करने और परीक्षा की विज्ञप्ति में दिए गए प्रावधानों के अनुसार आयोग की परीक्षाओं से वारित किया जाना शामिल है।"

**PART C**  
**General Engineering**  
**(MECHANICAL)**

1. (a) Define the following : 15
- (i) Reversible and Irreversible process
  - (ii) External and Internal irreversibility
  - (iii) Intensive and Extensive properties

- (b) Describe the following : 15
- (i) Clausius Statement
  - (ii) Kelvin-Planck Statement
  - (iii) Perpetual motion machine of the second kind

- (c) Volume of  $0.1 \text{ m}^3$  of an ideal gas at  $300 \text{ K}$  and  $1 \text{ bar}$  is compressed adiabatically to  $8 \text{ bar}$ . It is then cooled at constant volume and further expanded isothermally so as to reach the condition from where it started. Determine : 15

- (i) Pressure at the end of constant volume cooling
- (ii) Change in internal energy during constant volume process
- (iii) Net work done and heat transferred during the cycle.

Take  $c_p = 14.3 \text{ kJ/kg K}$  and  $c_v = 10.2 \text{ kJ/kg K}$ .

- (d) A reversible heat engine operates between two reservoirs at temperatures  $700^\circ\text{C}$  and  $50^\circ\text{C}$ . The engine drives a reversible refrigerator which operates between reservoirs at temperatures of  $50^\circ\text{C}$  and  $-25^\circ\text{C}$ . The heat transfer to the engine is  $2500 \text{ kJ}$  and the net work output of the combined engine refrigerator plant is  $400 \text{ kJ}$ .

- (i) Calculate the heat transfer to the refrigerant and the net heat transfer to the reservoir at  $50^\circ\text{C}$ ;
- (ii) Reconsider (i) given that the efficiency of the heat engine and the C.O.P. of the refrigerator are each 45 percent of their maximum possible values.

15

2.

(a) Give the comparisons between Otto cycle, Diesel cycle and Dual cycle.

15

(b) An air standard Otto cycle is to be designed according to the following specifications. Pressure at the start of the compression process = 101 kPa; Temperature at the start of the compression process = 300 K; Compression ratio = 8; Maximum pressure in the cycle = 8.0 MPa. Find

(i) the net work output per unit mass of air  $924.92$

(ii) cycle efficiency

(iii) MEP

15

(c) Explain the effect of Superheating and Sub-cooling on vapour compression refrigeration cycle.

15

(d) An air standard Brayton cycle has air entering the compressor at 100 kPa and 27°C. The pressure ratio is 10 and the maximum allowable temperature in the cycle is 1350 K. Determine

15

(i) temperatures at salient points of the cycle

(ii) compressor and turbine work per unit mass of air

(iii) net work output and work ratio

(iv) thermal efficiency of the cycle

(v) specific air consumption in kg/kWh

(vi) improvement in the thermal efficiency of the cycle if a regenerator with 100% effectiveness is incorporated in the cycle

3. (a) Define density, specific volume, weight density, specific gravity and Bulk Modulus. 15

(b) A ship weighing 4000 tons and having an area of  $465 \text{ m}^2$  at water line submerging to a depth of 4.5 m in sea water with a density of  $1024 \text{ kg/m}^3$  moves to fresh water. Determine the depth of submergence in fresh water. Assume that the sides are vertical at the water line. 15

$4 \times 10^6 \times 9.81$

$\rho_{sw} = 1024$

$4.5 \times 1024$

$\frac{1.27}{1000} = 4.1 \times$

(c) What is cavitation? How does it affect the performance of hydraulic machines? 15

(d) The following details refer to a centrifugal pump:

Outer diameter : 30 cm, Eye diameter : 15 cm, Blade angle at inlet :  $30^\circ$ , Blade angle at outlet :  $25^\circ$ , Speed 1450 rpm. The flow velocity remains constant. The whirl at inlet is zero.

Determine the work done per kg. If the manometric efficiency is 82%, determine the working head. If width at outlet is 2 m, determine the power  $\eta_0 = 76\%$ . 15

$d_2 = \text{---}$

$d_1 = \text{---}$

$\theta = 30^\circ$

$\phi = 25^\circ$

$V_{f2} = \text{---}$

$\eta_m = \frac{gH_m}{V_{w2} U_2}$

$P = \rho g Q H_m$

$Q = A_1 V_{f1}$   
 $= \pi d b V_h$

$\frac{mg}{V}$

4. (a) Write short notes on the following:

- (i) Stainless steel
- (ii) High speed steel
- (iii) High carbon steel



(b) With the help of figure, describe the Shielded Metal Arc Welding process. 15

(c) Explain the different operations performed in grinding machine. 15

(d) Mention the differences between shaper and planer machine tools. 15

$V_{f2} = V_{f1} \left( \frac{d_1}{d_2} \right)^2$

5. (a) Give the classification of kinematic pairs. 15

(b) An engine, running at 150 r.p.m., drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft being 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Calculate the speed of the dynamo shaft, when (i) there is no slip, and (ii) there is a slip of 2% at each drive. 15

$$P N_1 = P N_2 = P N$$

(c) Mention the comparison between involute and cycloidal gears. 15

(d) Explain the term height of the governor. Derive an expression for the height in the case of a Watt governor. 15

6. (a) Three forces of 2P, 3P and 4P act along the three sides of an equilateral triangle of side 100 mm taken in order. Find the magnitude and position of the resultant force. 15



(b) A body of weight 300 N is lying on a rough horizontal plane having a coefficient of friction as 0.3. Find the magnitude of the force, which can move the body, while acting at an angle of 25° with the horizontal. 15

(c) Derive the expression for the shear stress in a circular shaft subjected to torsion. 15

(d) Derive the expression for circumferential stress in a thin cylindrical vessel. 15

