# GATE 2014: General Instructions during Examination

1. Total duration of the GATE examination is **180** minutes.
2. The clock will be set at the server. The countdown timer at the top right corner of screen will display the remaining time available for you to complete the examination. When the timer reaches zero, the examination will end by itself. You need not terminate the examination or submit your paper.
3. Any useful data required for your paper can be viewed by clicking on the **Useful Common Data** button that appears on the screen.
4. Use the scribble pad provided to you for any rough work. Submit the scribble pad at the end of the examination.
5. You are allowed to use a non-programmable type calculator, however, sharing of calculators is not allowed.
6. The Question Palette displayed on the right side of screen will show the status of each question using one of the following symbols:

| | |
|---|---|
| **1** | You have not visited the question yet. |
| **3** | You have not answered the question. |
| **5** | You have answered the question. |
| **7** | You have NOT answered the question, but have marked the question for review. |
| **9** | You have answered the question, but marked it for review. |

The **Marked for Review** status for a question simply indicates that you would like to look at that question again. *If a question is answered, but marked for review, then the answer will be considered for evaluation unless the status is modified by the candidate.*

**Navigating to a Question :**

7. To answer a question, do the following:
   a. Click on the question number in the Question Palette to go to that question directly.
   b. Select an answer for a multiple choice type question by clicking on the bubble placed before the 4 choices, namely A, B, C and D. Use the virtual numeric keypad to enter a number as answer for a numerical type question.
   c. Click on **Save & Next** to save your answer for the current question and then go to the next question.
   d. Click on **Mark for Review & Next** to save your answer for the current question and also mark it for review, and then go to the next question.

**Caution:** Note that your answer for the current question will not be saved, if you navigate to another question directly by clicking on a question number without saving the answer to the previous question.

You can view all the questions by clicking on the **Question Paper** button. This feature is provided, so that if you want you can just see the entire question paper at a glance.

## Answering a Question :

8. Procedure for answering a multiple choice (MCQ) type question:
    a. Choose one answer from the 4 options (A,B,C,D) given below the question, click on the bubble placed before the chosen option.
    b. To deselect your chosen answer, click on the bubble of the chosen option again or click on the **Clear Response** button.
    c. To change your chosen answer, click on the bubble of another option.
    d. To save your answer, you MUST click on the **Save & Next** button.

9. Procedure for answering a numerical answer type question:
    a. To enter a number as your answer, use the virtual numerical keypad.
    b. A fraction (e.g. -0.3 or -.3) can be entered as an answer with or without '0' before the decimal point. As many as four decimal points, e.g. 12.5435 or 0.003 or -932.6711 or 12.82 can be entered.
    c. To clear your answer, click on the **Clear Response** button.
    d. To save your answer, you MUST click on the **Save & Next** button
10. To mark a question for review, click on the **Mark for Review & Next** button. *If an answer is selected (for MCQ) or entered (for numerical answer type) for a question that is **Marked for Review**, that answer will be considered in the evaluation unless the status is modified by the candidate.*

11. To change your answer to a question that has already been answered, first select that question for answering and then follow the procedure for answering that type of question.
12. Note that ONLY Questions for which answers are *saved* or *marked for review after answering* will be considered for evaluation.

### Choosing a Section :

13. Sections in this question paper are displayed on the top bar of the screen. Questions in a Section can be viewed by clicking on the name of that Section. The Section you are currently viewing will be highlighted.
14. A checkbox is displayed for every optional Section, if any, in the Question Paper. To select the optional Section for answering, click on the checkbox for that Section.
15. If the checkbox for an optional Section is not selected, the **Save & Next** button and the **Mark for Review & Next** button will NOT be enabled for that Section. You will

only be able to see questions in this Section, but you will not be able to answer questions in the Section.

16. After clicking the **Save & Next** button for the last question in a Section, you will automatically be taken to the first question of the next Section in sequence.

17. You can move the mouse cursor over the name of a Section to view the answering status for that Section.

## Changing the Optional Section :

18. After answering the chosen optional Section, partially or completely, you can change the optional Section by selecting the checkbox for a new Section that you want to attempt. A warning message will appear along with a table showing the number of questions answered in each of the previously chosen optional Sections and a checkbox against each of these Sections. Click on a checkbox against a Section that you want to reset and then click on the **RESET** button. Note that RESETTING a Section will DELETE all the answers for questions in that Section. Hence, if you think that you may want to select this Section again later, you will have to note down your answers for questions in that Section. If you do not want to reset the Section and want to continue answering the previously chosen optional Section, then click on the **BACK** button.

19. If you deselect the checkbox for an optional Section in the top bar, the following warning message will appear: "Deselecting the checkbox will DELETE all the answers for questions in this Section. Do you want to deselect this Section?" If you want to deselect, click on the **RESET** button. If you do not want to deselect, click on the **BACK** button.

20. You can shuffle between different Sections or change the optional Sections any number of times.

# GATE 2014 Examination

# ME: Mechanical Engineering

*Duration*: **180 minutes**                                                              *Maximum Marks*: **100**

## Read the following instructions carefully.

1. To login, enter your Registration Number and password provided to you. Kindly go through the various symbols used in the test and understand their meaning before you start the examination.
2. Once you login and after the start of the examination, you can view all the questions in the question paper, by clicking on the **View All Questions** button in the screen.
3. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory.
   The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each.
   The subject specific GATE paper section consists of **55** questions, out of which question numbers 1 to 25 are of 1-mark each, while question numbers 26 to 55 are of 2-mark each.
4. Depending upon the GATE paper, there may be useful common data that may be required for answering the questions. If the paper has such useful data, the same can be viewed by clicking on the **Useful Common Data** button that appears at the top, right hand side of the screen.

5. The computer allotted to you at the examination center runs specialized software that permits only one answer to be selected for multiple-choice questions using a mouse and to enter a suitable number for the numerical answer type questions using the virtual keyboard and mouse.
6. Your answers shall be updated and saved on a server periodically and also at the end of the examination. The examination will **stop automatically** at the end of **180 minutes**.
7. In each paper a candidate can answer a total of 65 questions carrying 100 marks.
8. The question paper may consist of questions of **multiple choice type** (MCQ) and **numerical answer type**.
9. Multiple choice type questions will have four choices against A, B, C, D, out of which only **ONE** is the correct answer. The candidate has to choose the correct answer by clicking on the bubble (◯) placed before the choice.
10. For numerical answer type questions, each question will have a numerical answer and there will not be any choices**. For these questions, the answer should be entered**by using the virtual keyboard that appears on the monitor and the mouse.
11. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of⅓ marks for a 1-mark question and ⅔ marks for a 2-mark question.
12. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.

13. Non-programmable type Calculator is allowed. Charts, graph sheets, and mathematical tables are **NOT** allowed in the Examination Hall. You must use the Scribble pad provided to you at the examination centre for all your rough work. The Scribble Pad has to be returned at the end of the examination.

**Declaration by the candidate:**

"I have read and understood all the above instructions. I have also read and understood clearly the instructions given on the admit card and shall follow the same. I also understand that in case I am found to violate any of these instructions, my candidature is liable to be cancelled. I also confirm that at the start of the examination all the computer hardware allotted to me are in proper working condition".

**Q. 1 – Q. 5 carry one mark each.**

Q.1    Choose the most appropriate phrase from the options given below to complete the following sentence.

The aircraft _____ take off as soon as its flight plan was filed.

(A) is allowed to                          (B) will be allowed to
(C) was allowed to                       (D) has been allowed to

Q.2    Read the statements:

All women are entrepreneurs.
Some women are doctors.

Which of the following conclusions can be logically inferred from the above statements?

(A) All women are doctors                (B) All doctors are entrepreneurs
(C) All entrepreneurs are women          (D) Some entrepreneurs are doctors

Q.3    Choose the most appropriate word from the options given below to complete the following sentence.

Many ancient cultures attributed disease to supernatural causes. However, modern science has largely helped _____ such notions.

(A) impel          (B) dispel          (C) propel          (D) repel

Q.4    The statistics of runs scored in a series by four batsmen are provided in the following table. Who is the most <u>consistent</u> batsman of these four?

| Batsman | Average | Standard deviation |
|---------|---------|--------------------|
| K       | 31.2    | 5.21               |
| L       | 46.0    | 6.35               |
| M       | 54.4    | 6.22               |
| N       | 17.9    | 5.90               |

(A) K          (B) L          (C) M          (D) N

Q.5    What is the next number in the series?

12      35      81      173      357      ____

**Q. 6 – Q. 10 carry two marks each.**

Q.6    Find the odd one from the following group:

W,E,K,O        I,Q,W,A        F,N,T,X        N,V,B,D

(A) W,E,K,O          (B) I,Q,W,A          (C) F,N,T,X          (D) N,V,B,D

Q.7    For submitting tax returns, all resident males with annual income below Rs 10 lakh should fill up Form P and all resident females with income below Rs 8 lakh should fill up Form Q. All people with incomes above Rs 10 lakh should fill up Form R, except non residents with income above Rs 15 lakhs, who should fill up Form S. All others should fill Form T. An example of a person who should fill Form T is

(A) a resident male with annual income Rs 9 lakh
(B) a resident female with annual income Rs 9 lakh
(C) a non-resident male with annual income Rs 16 lakh
(D) a non-resident female with annual income Rs 16 lakh

Q.8    A train that is 280 metres long, travelling at a uniform speed, crosses a platform in 60 seconds and passes a man standing on the platform in 20 seconds. What is the length of the platform in metres?

Q.9    The exports and imports (in crores of Rs.) of a country from 2000 to 2007 are given in the following bar chart. If the trade deficit is defined as excess of imports over exports, in which year is the trade deficit 1/5th of the exports?



(A) 2005          (B) 2004          (C) 2007          (D) 2006

Q.10    You are given three coins: one has heads on both faces, the second has tails on both faces, and the third has a head on one face and a tail on the other. You choose a coin at random and toss it, and it comes up heads. The probability that the other face is tails is

(A) 1/4          (B) 1/3          (C) 1/2          (D) 2/3

# END OF THE QUESTION PAPER

## Q. 1 – Q. 25 carry one mark each.

Q.1 Given that the determinant of the matrix $\begin{bmatrix} 1 & 3 & 0 \\ 2 & 6 & 4 \\ -1 & 0 & 2 \end{bmatrix}$ is $-12$, the determinant of the matrix

$\begin{bmatrix} 2 & 6 & 0 \\ 4 & 12 & 8 \\ -2 & 0 & 4 \end{bmatrix}$ is

(A) $-96$          (B) $-24$          (C) $24$          (D) $96$

Q.2 $\displaystyle \operatorname*{Lt}_{x \to 0} \frac{x - \sin x}{1 - \cos x}$ is

(A) $0$          (B) $1$          (C) $3$          (D) not defined

Q.3 The argument of the complex number $\dfrac{1+i}{1-i}$, where $i = \sqrt{-1}$, is

(A) $-\pi$          (B) $-\dfrac{\pi}{2}$          (C) $\dfrac{\pi}{2}$          (D) $\pi$

Q.4 The matrix form of the linear system $\dfrac{dx}{dt} = 3x - 5y$ and $\dfrac{dy}{dt} = 4x + 8y$ is

(A) $\dfrac{d}{dt}\begin{Bmatrix} x \\ y \end{Bmatrix} = \begin{bmatrix} 3 & -5 \\ 4 & 8 \end{bmatrix}\begin{Bmatrix} x \\ y \end{Bmatrix}$          (B) $\dfrac{d}{dt}\begin{Bmatrix} x \\ y \end{Bmatrix} = \begin{bmatrix} 3 & 8 \\ 4 & -5 \end{bmatrix}\begin{Bmatrix} x \\ y \end{Bmatrix}$

(C) $\dfrac{d}{dt}\begin{Bmatrix} x \\ y \end{Bmatrix} = \begin{bmatrix} 4 & -5 \\ 3 & 8 \end{bmatrix}\begin{Bmatrix} x \\ y \end{Bmatrix}$          (D) $\dfrac{d}{dt}\begin{Bmatrix} x \\ y \end{Bmatrix} = \begin{bmatrix} 4 & 8 \\ 3 & -5 \end{bmatrix}\begin{Bmatrix} x \\ y \end{Bmatrix}$

Q.5 Which one of the following describes the relationship among the three vectors, $\hat{i} + \hat{j} + \hat{k}$, $2\hat{i} + 3\hat{j} + \hat{k}$ and $5\hat{i} + 6\hat{j} + 4\hat{k}$?

(A) The vectors are mutually perpendicular      (B) The vectors are linearly dependent
(C) The vectors are linearly independent      (D) The vectors are unit vectors

Q.6 A circular rod of length '$L$' and area of cross-section '$A$' has a modulus of elasticity '$E$' and coefficient of thermal expansion '$\alpha$'. One end of the rod is fixed and other end is free. If the temperature of the rod is increased by $\Delta T$, then

(A) stress developed in the rod is $E\,\alpha\,\Delta T$ and strain developed in the rod is $\alpha\,\Delta T$
(B) both stress and strain developed in the rod are zero
(C) stress developed in the rod is zero and strain developed in the rod is $\alpha\,\Delta T$
(D) stress developed in the rod is $E\,\alpha\,\Delta T$ and strain developed in the rod is zero

Q.7　　A metallic rod of 500 mm length and 50 mm diameter, when subjected to a tensile force of 100 kN at the ends, experiences an increase in its length by 0.5 mm and a reduction in its diameter by 0.015 mm. The Poisson's ratio of the rod material is _____

Q.8　　Critical damping is the

(A) largest amount of damping for which no oscillation occurs in free vibration
(B) smallest amount of damping for which no oscillation occurs in free vibration
(C) largest amount of damping for which the motion is simple harmonic in free vibration
(D) smallest amount of damping for which the motion is simple harmonic in free vibration

Q.9　　A circular object of radius $r$ rolls without slipping on a horizontal level floor with the center having velocity $V$. The velocity at the point of contact between the object and the floor is

(A) zero
(B) $V$ in the direction of motion
(C) $V$ opposite to the direction of motion
(D) $V$ vertically upward from the floor

Q.10　For the given statements:

I. Mating spur gear teeth is an example of higher pair
II. A revolute joint is an example of lower pair

Indicate the correct answer.

(A) Both I and II are false
(B) I is true and II is false
(C) I is false and II is true
(D) Both I and II are true

Q.11　A rigid link PQ is 2 m long and oriented at 20º to the horizontal as shown in the figure. The magnitude and direction of velocity $V_Q$, and the direction of velocity $V_P$ are given. The magnitude of $V_P$ (in m/s) at this instant is
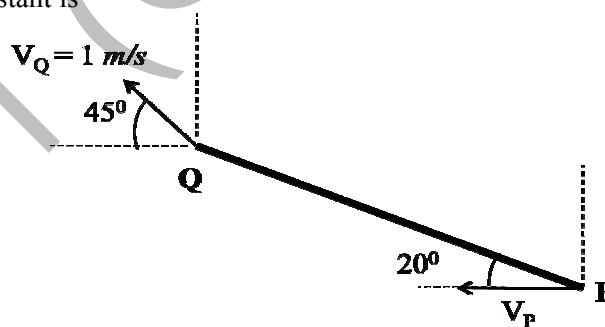


(A) 2.14　　　　(B) 1.89　　　　(C) 1.21　　　　(D) 0.96

Q.12　Biot number signifies the ratio of

(A) convective resistance in the fluid to conductive resistance in the solid
(B) conductive resistance in the solid to convective resistance in the fluid
(C) inertia force to viscous force in the fluid
(D) buoyancy force to viscous force in the fluid

Q.13    The maximum theoretical work obtainable, when a system interacts to equilibrium with a reference environment, is called

(A) Entropy          (B) Enthalpy          (C) Exergy          (D) Rothalpy

Q.14    Consider a two-dimensional laminar flow over a long cylinder as shown in the figure below.
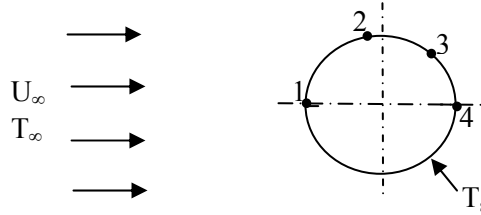


The free stream velocity is $U_\infty$ and the free stream temperature $T_\infty$ is lower than the cylinder surface temperature $T_s$. The local heat transfer coefficient is minimum at point

(A) 1          (B) 2          (C) 3          (D) 4

Q.15    For a completely submerged body with centre of gravity 'G' and centre of buoyancy 'B', the condition of stability will be

(A) G is located below B                    (B) G is located above B
(C) G and B are coincident                 (D) independent of the locations of G and B

Q.16    In a power plant, water (density = 1000 kg/m$^3$) is pumped from 80 kPa to 3 MPa. The pump has an isentropic efficiency of 0.85. Assuming that the temperature of the water remains the same, the specific work (in kJ/kg) supplied to the pump is

(A) 0.34          (B) 2.48          (C) 2.92          (D) 3.43

Q.17    Which one of the following is a CFC refrigerant?

(A) R744          (B) R290          (C) R502          (D) R718

Q.18    The jobs arrive at a facility, for service, in a random manner. The probability distribution of number of arrivals of jobs in a fixed time interval is

(A) Normal          (B) Poisson          (C) Erlang          (D) Beta

Q.19    In exponential smoothening method, which one of the following is true?

(A) $0 \leq \alpha \leq 1$ and high value of $\alpha$ is used for stable demand
(B) $0 \leq \alpha \leq 1$ and high value of $\alpha$ is used for unstable demand
(C) $\alpha \geq 1$ and high value of $\alpha$ is used for stable demand
(D) $\alpha \leq 0$ and high value of $\alpha$ is used for unstable demand

Q.20   For machining a rectangular island represented by coordinates P(0,0), Q(100,0), R(100,50) and
       S(0,50) on a casting using CNC milling machine, an end mill with a diameter of 16 mm is used.
       The trajectory of the cutter centre to machine the island PQRS is

       (A) (−8, −8), (108, −8), (108,58), (−8,58) , (−8, −8)

       (B) (8,8), (94,8), (94,44), (8,44), (8,8)

       (C) (−8,8), (94,0), (94,44), (8,44), (−8,8)

       (D) (0,0), (100,0), (100,50), (50,0), (0,0)

Q.21   Which one of the following instruments is widely used to check and calibrate geometric features of
       machine tools during their assembly?

       (A) Ultrasonic probe                      (B) Coordinate Measuring Machine (CMM)
       (C) Laser interferometer                  (D) Vernier calipers

Q.22   The major difficulty during welding of aluminium is due to its

       (A) high tendency of oxidation            (B) high thermal conductivity
       (C) low melting point                     (D) low density

Q.23   The main cutting force acting on a tool during the turning (orthogonal cutting) operation of a metal
       is 400 N. The turning was performed using 2 mm depth of cut and 0.1 mm/rev feed rate. The
       specific cutting pressure (in N/mm$^2$) is

       (A) 1000            (B) 2000            (C) 3000            (D) 4000

Q.24   The process of reheating the martensitic steel to reduce its brittleness without any significant loss in
       its hardness is

       (A) normalising     (B) annealing       (C)  quenching      (D)  tempering

Q.25   In solid-state welding, the contamination layers between the surfaces to be welded are removed by

       (A) alcohol                               (B) plastic deformation
       (C) water jet                             (D) sand blasting

**Q. 26 – Q. 55 carry two marks each.**

Q.26　The integral $\oint_C (y\,dx - x\,dy)$ is evaluated along the circle $x^2 + y^2 = \dfrac{1}{4}$ traversed in counter clockwise direction. The integral is equal to

(A) 0　　　　　(B) $-\dfrac{\pi}{4}$　　　　　(C) $-\dfrac{\pi}{2}$　　　　　(D) $\dfrac{\pi}{4}$

Q.27　If $y = f(x)$ is the solution of $\dfrac{d^2 y}{dx^2} = 0$ with the boundary conditions $y = 5$ at $x = 0$, and $\dfrac{dy}{dx} = 2$ at $x = 10$, $f(15) = $ _____

Q.28　In the following table, $x$ is a discrete random variable and $p(x)$ is the probability density. The standard deviation of $x$ is

| $x$ | 1 | 2 | 3 |
|---|---|---|---|
| $p(x)$ | 0.3 | 0.6 | 0.1 |

(A) 0.18　　　　(B) 0.36　　　　(C) 0.54　　　　(D) 0.6

Q.29　Using the trapezoidal rule, and dividing the interval of integration into three equal subintervals, the definite integral $\displaystyle\int_{-1}^{+1} |x|\,dx$ is _____

Q.30　The state of stress at a point is given by $\sigma_x = -6$ MPa, $\sigma_y = 4$ MPa, and $\tau_{xy} = -8$ MPa. The maximum tensile stress (in MPa) at the point is _____

Q.31　A block R of mass 100 kg is placed on a block $S$ of mass 150 kg as shown in the figure. Block R is tied to the wall by a massless and inextensible string PQ. If the coefficient of static friction for all surfaces is 0.4, the minimum force **F** (in kN) needed to move the block $S$ is
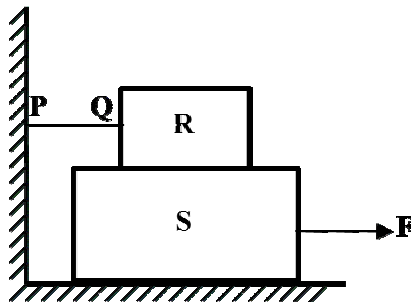


(A) 0.69　　　　(B) 0.88　　　　(C) 0.98　　　　(D) 1.37

Q.32    A pair of spur gears with module 5 mm and a center distance of 450 mm is used for a speed reduction of 5:1. The number of teeth on pinion is _____

Q.33    Consider a cantilever beam, having negligible mass and uniform flexural rigidity, with length 0.01 m. The frequency of vibration of the beam, with a 0.5 kg mass attached at the free tip, is 100 Hz. The flexural rigidity (in N.m$^2$) of the beam is _____

Q.34    An ideal water jet with volume flow rate of 0.05 m$^3$/s strikes a flat plate placed normal to its path and exerts a force of 1000 N. Considering the density of water as 1000 kg/m$^3$, the diameter (in mm) of the water jet is _____

Q.35    A block weighing 200 N is in contact with a level plane whose coefficients of static and kinetic friction are 0.4 and 0.2, respectively. The block is acted upon by a horizontal force (in newton) $P$=10$t$, where $t$ denotes the time in seconds. The velocity (in m/s) of the block attained after 10 seconds is _____

Q.36    A slider crank mechanism has slider mass of 10 kg, stroke of 0.2 m and rotates with a uniform angular velocity of 10 rad/s. The primary inertia forces of the slider are partially balanced by a revolving mass of 6 kg at the crank, placed at a distance equal to crank radius. Neglect the mass of connecting rod and crank. When the crank angle (with respect to slider axis) is 30°, the unbalanced force (in newton) normal to the slider axis is _____

Q.37    An offset slider-crank mechanism is shown in the figure at an instant. Conventionally, the Quick Return Ratio (QRR) is considered to be greater than one. The value of QRR is _____
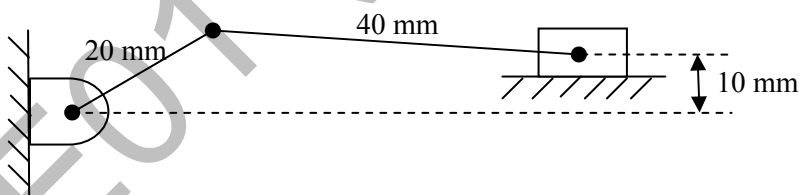
Q.38   A rigid uniform rod *AB* of length *L* and mass *m* is hinged at *C* such that *AC* = *L*/3, *CB* = 2*L*/3. Ends *A* and *B* are supported by springs of spring constant *k*. The natural frequency of the system is given by
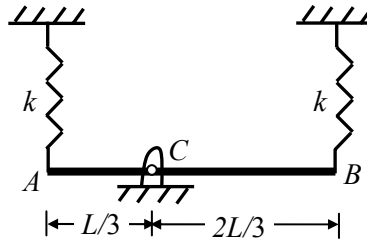


(A) $\sqrt{\dfrac{k}{2m}}$         (B) $\sqrt{\dfrac{k}{m}}$         (C) $\sqrt{\dfrac{2k}{m}}$         (D) $\sqrt{\dfrac{5k}{m}}$

Q.39   A hydrodynamic journal bearing is subject to 2000 N load at a rotational speed of 2000 rpm. Both bearing bore diameter and length are 40 mm. If radial clearance is 20 μm and bearing is lubricated with an oil having viscosity 0.03 Pa.s, the Sommerfeld number of the bearing is _____

Q.40   A 200 mm long, stress free rod at room temperature is held between two immovable rigid walls. The temperature of the rod is uniformly raised by 250°C. If the Young's modulus and coefficient of thermal expansion are 200 GPa and $1\times10^{-5}$ /°C, respectively, the magnitude of the longitudinal stress (in MPa) developed in the rod is _____

Q.41   1.5 kg of water is in saturated liquid state at 2 bar ($v_f$ = 0.001061 m³/kg, $u_f$ = 504.0 kJ/kg, $h_f$ = 505 kJ/kg). Heat is added in a constant pressure process till the temperature of water reaches 400°C ($v$ = 1.5493 m³/kg, $u$ = 2967.0 kJ/kg, $h$ = 3277.0 kJ/kg). The heat added (in kJ) in the process is _____

Q.42　Consider one dimensional steady state heat conduction across a wall (as shown in figure below) of thickness 30 mm and thermal conductivity 15 W/m.K. At $x = 0$, a constant heat flux, $q'' = 1 \times 10^5$ W/m$^2$ is applied. On the other side of the wall, heat is removed from the wall by convection with a fluid at 25°C and heat transfer coefficient of 250 W/m$^2$.K. The temperature (in °C), at $x = 0$ is _____
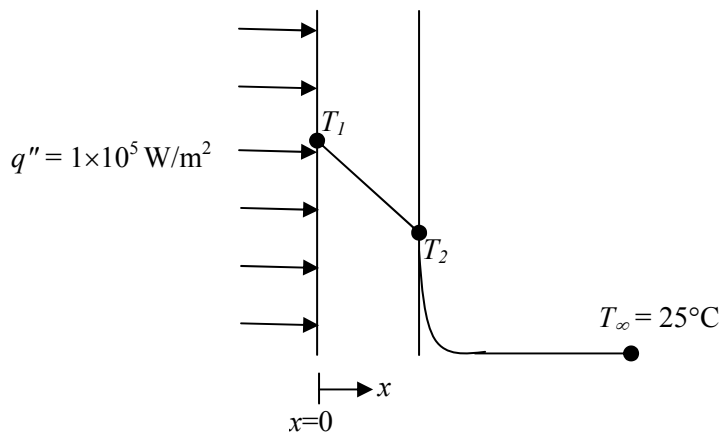


Q.43　Water flows through a pipe having an inner radius of 10 mm at the rate of 36 kg/hr at 25°C. The viscosity of water at 25°C is 0.001 kg/m.s. The Reynolds number of the flow is _____

Q.44　For a fully developed flow of water in a pipe having diameter 10 cm, velocity 0.1 m/s and kinematic viscosity $10^{-5}$ m$^2$/s, the value of Darcy friction factor is _____

Q.45　In a simple concentric shaft-bearing arrangement, the lubricant flows in the 2 mm gap between the shaft and the bearing. The flow may be assumed to be a plane Couette flow with zero pressure gradient. The diameter of the shaft is 100 mm and its tangential speed is 10 m/s. The dynamic viscosity of the lubricant is 0.1 kg/m.s. The frictional resisting force (in newton) per 100 mm length of the bearing is _____

Q.46　The non-dimensional fluid temperature profile near the surface of a convectively cooled flat plate is given by $\dfrac{T_W - T}{T_W - T_\infty} = a + b\dfrac{y}{L} + c\left(\dfrac{y}{L}\right)^2$, where $y$ is measured perpendicular to the plate, $L$ is the plate length, and $a$, $b$ and $c$ are arbitrary constants. $T_W$ and $T_\infty$ are wall and ambient temperatures, respectively. If the thermal conductivity of the fluid is $k$ and the wall heat flux is $q''$, the Nusselt number $Nu = \dfrac{q''}{T_W - T_\infty}\dfrac{L}{k}$ is equal to

(A) $a$　　　　　　　　(B) $b$　　　　　　　　(C) $2c$　　　　　　　　(D) $(b+2c)$

Q.47 In an air-standard Otto cycle, air is supplied at 0.1 MPa and 308 K. The ratio of the specific heats ($\gamma$) and the specific gas constant ($R$) of air are 1.4 and 288.8 J/kg.K, respectively. If the compression ratio is 8 and the maximum temperature in the cycle is 2660 K, the heat (in kJ/kg) supplied to the engine is _____

Q.48 A reversible heat engine receives 2 kJ of heat from a reservoir at 1000 K and a certain amount of heat from a reservoir at 800 K. It rejects 1 kJ of heat to a reservoir at 400 K. The net work output (in kJ) of the cycle is

(A) 0.8         (B) 1.0         (C) 1.4         (D) 2.0

Q.49 An ideal reheat Rankine cycle operates between the pressure limits of 10 kPa and 8 MPa, with reheat being done at 4 MPa. The temperature of steam at the inlets of both turbines is 500°C and the enthalpy of steam is 3185 kJ/kg at the exit of the high pressure turbine and 2247 kJ/kg at the exit of low pressure turbine. The enthalpy of water at the exit from the pump is 191 kJ/kg. Use the following table for relevant data.

| Superheated steam temperature (°C) | Pressure (MPa) | $v$ (m³/kg) | $h$ (kJ/kg) | $s$ (kJ/kg.K) |
|---|---|---|---|---|
| 500 | 4 | 0.08644 | 3446 | 7.0922 |
| 500 | 8 | 0.04177 | 3399 | 6.7266 |

Disregarding the pump work, the cycle efficiency (in percentage) is _____

Q.50 Jobs arrive at a facility at an average rate of 5 in an 8 hour shift. The arrival of the jobs follows Poisson distribution. The average service time of a job on the facility is 40 minutes. The service time follows exponential distribution. Idle time (in hours) at the facility per shift will be

(A) $\dfrac{5}{7}$       (B) $\dfrac{14}{3}$       (C) $\dfrac{7}{5}$       (D) $\dfrac{10}{3}$

Q.51 A metal rod of initial length $L_0$ is subjected to a drawing process. The length of the rod at any instant is given by the expression, $L(t) = L_0(1 + t^2)$, where $t$ is the time in minutes. The true strain rate (in min⁻¹) at the end of one minute is _____

Q.52 During pure orthogonal turning operation of a hollow cylindrical pipe, it is found that the thickness of the chip produced is 0.5 mm. The feed given to the zero degree rake angle tool is 0.2 mm/rev. The shear strain produced during the operation is _____

Q.53    For the given assembly: 25 H7/g8, match Group A with Group B

| Group A | Group B |
|---------|---------|
| P.   H | I.   Shaft Type |
| Q.   IT8 | II.   Hole Type |
| R.   IT7 | III.   Hole Tolerance Grade |
| S.   g | IV.   Shaft Tolerance Grade |

(A) P-I, Q-III, R-IV, S-II                    (B) P-I, Q-IV, R-III, S-II

(C) P-II, Q-III, R-IV, S-I                    (D) P-II, Q-IV, R-III, S-I


Q.54    If the Taylor's tool life exponent $n$ is 0.2, and the tool changing time is 1.5 min, then the tool life (in min)  for maximum production rate is _____


Q.55    An aluminium alloy (density 2600 kg/m$^3$) casting is to be produced. A cylindrical hole of 100 mm diameter and 100 mm length is made in the casting using sand core (density 1600 kg/m$^3$).  The net buoyancy force (in newton) acting on the core is _____


# END OF THE QUESTION PAPER