SESSION - 2

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 th

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 word from the options given below to complete the following sentence.

Communication and interpersonal skills are _____ important in their own ways.

(A) each   (B) both   (C) all   (D) either

Q.2   Which of the options given below best completes the following sentence?

She will feel much better if she _____.

(A) will get some rest   (B) gets some rest
(C) will be getting some rest   (D) is getting some rest

Q.3   Choose the most appropriate pair of words from the options given below to complete the following sentence.

She could not _____ the thought of _____ the election to her bitter rival.

(A) bear, loosing   (B) bare, loosing   (C) bear, losing   (D) bare, losing

Q.4   A regular die has six sides with numbers 1 to 6 marked on its sides. If a very large number of throws show the following frequencies of occurrence: $1 \rightarrow 0.167; 2 \rightarrow 0.167; 3 \rightarrow 0.152; 4 \rightarrow 0.166; 5 \rightarrow 0.168; 6 \rightarrow 0.180$. We call this die

(A) irregular   (B) biased   (C) Gaussian   (D) insufficient

Q.5   Fill in the missing number in the series.

2   3   6   15   ___   157.5   630

Q. 6 – Q. 10 carry two marks each.

Q.6   Find the odd one in the following group

Q,W,Z,B   B,H,K,M   W,C,G,J   M,S,V,X

(A) Q,W,Z,B   (B) B,H,K,M   (C) W,C,G,J   (D) M,S,V,X

Q.7   Lights of four colors (red, blue, green, yellow) are hung on a ladder. On every step of the ladder there are two lights. If one of the lights is red, the other light on that step will always be blue. If one of the lights on a step is green, the other light on that step will always be yellow. Which of the following statements is not necessarily correct?

(A) The number of red lights is equal to the number of blue lights
(B) The number of green lights is equal to the number of yellow lights
(C) The sum of the red and green lights is equal to the sum of the yellow and blue lights
(D) The sum of the red and blue lights is equal to the sum of the green and yellow lights

Q.8   The sum of eight consecutive odd numbers is 656. The average of four consecutive even numbers is 87. What is the sum of the smallest odd number and second largest even number?

Q.9   The total exports and revenues from the exports of a country are given in the two charts shown below. The pie chart for exports shows the quantity of each item exported as a percentage of the total quantity of exports. The pie chart for the revenues shows the percentage of the total revenue generated through export of each item. The total quantity of exports of all the items is 500 thousand tonnes and the total revenues are 250 crore rupees. Which item among the following has generated the maximum revenue per kg?

Exports

Revenues
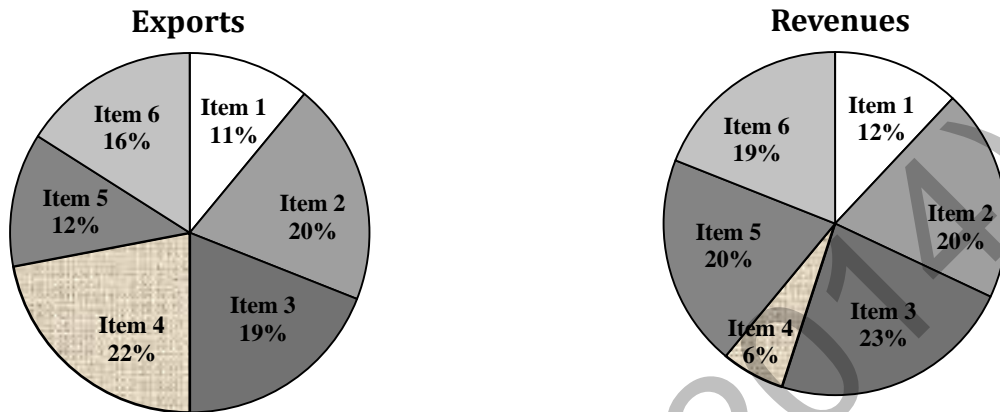
(A) Item 2   (B) Item 3   (C) Item 6   (D) Item 5

Q.10   It takes 30 minutes to empty a half-full tank by draining it at a constant rate. It is decided to simultaneously pump water into the half-full tank while draining it. What is the rate at which water has to be pumped in so that it gets fully filled in 10 minutes?

(A) 4 times the draining rate   (B) 3 times the draining rate
(C) 2.5 times the draining rate   (D) 2 times the draining rate

END OF THE QUESTION PAPER

Q. 1 – Q. 25 carry one mark each.

Q.1 One of the eigenvectors of the matrix $\begin{bmatrix} -5 & 2 \\ -9 & 6 \end{bmatrix}$ is

(A) $\begin{Bmatrix} -1 \\ 1 \end{Bmatrix}$ (B) $\begin{Bmatrix} -2 \\ 9 \end{Bmatrix}$ (C) $\begin{Bmatrix} 2 \\ -1 \end{Bmatrix}$ (D) $\begin{Bmatrix} 1 \\ 1 \end{Bmatrix}$

Q.2 $\underset{x \to 0}{\mathrm{Lt}} \left(\dfrac{e^{2x} - 1}{\sin(4x)} \right)$ is equal to

(A) 0   (B) 0.5   (C) 1   (D) 2

Q.3 Curl of vector $\vec{F} = x^2 z^2 \hat{i} - 2xy^2 z \hat{j} + 2y^2 z^3 \hat{k}$ is

(A) $(4yz^3 + 2xy^2)\hat{i} + 2x^2 z\hat{j} - 2y^2 z\hat{k}$ (B) $(4yz^3 + 2xy^2)\hat{i} - 2x^2 z\hat{j} - 2y^2 z\hat{k}$

(C) $2xz^2\hat{i} - 4xyz\hat{j} + 6y^2 z^2\hat{k}$ (D) $2xz^2\hat{i} + 4xyz\hat{j} + 6y^2 z^2\hat{k}$

Q.4 A box contains 25 parts of which 10 are defective. Two parts are being drawn simultaneously in a random manner from the box. The probability of both the parts being good is

(A) $\dfrac{7}{20}$ (B) $\dfrac{42}{125}$ (C) $\dfrac{25}{29}$ (D) $\dfrac{5}{9}$

Q.5 The best approximation of the minimum value attained by $e^{-x} \sin(100x)$ for $x \geq 0$ is _____

Q.6 A steel cube, with all faces free to deform, has Young's modulus, E, Poisson's ratio, v, and coefficient of thermal expansion, α. The pressure (hydrostatic stress) developed within the cube, when it is subjected to a uniform increase in temperature, ΔT, is given by

(A) 0   (B) $\dfrac{\alpha(\Delta T)E}{1 - 2v}$ (C) $-\dfrac{\alpha(\Delta T)E}{1 - 2v}$ (D) $\dfrac{\alpha(\Delta T)E}{3(1 - 2v)}$

Q.7   A two member truss *ABC* is shown in the figure. The force (in kN) transmitted in member *AB* is
_____
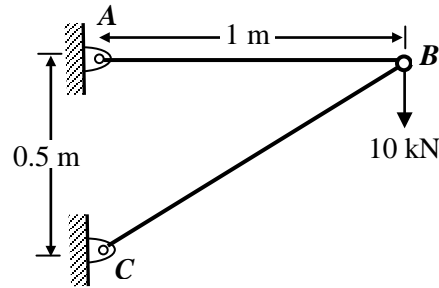
Q.8   A 4-bar mechanism with all revolute pairs has link lengths l_f = 20 mm, l_{in} = 40 mm, l_{co} = 50 mm
and l_{out} = 60 mm. The suffixes '*f*', '*in*', '*co*' and '*out*' denote the fixed link, the input link, the coupler
and output link respectively. Which one of the following statements is true about the input and
output links?

(A) Both links can execute full circular motion
(B) Both links cannot execute full circular motion
(C) Only the output link cannot execute full circular motion
(D) Only the input link cannot execute full circular motion

Q.9   In vibration isolation, which one of the following statements is **NOT** correct regarding
Transmissibility (*T*)?

(A) *T* is nearly unity at small excitation frequencies

(B) *T* can be always reduced by using higher damping at any excitation frequency

(C) *T* is unity at the frequency ratio of $\sqrt{2}$

(D) *T* is infinity at resonance for undamped systems

Q.10   In a structure subjected to fatigue loading, the minimum and maximum stresses developed in a
cycle are 200 MPa and 400 MPa respectively. The value of stress amplitude (in MPa) is _____

Q.11   A thin plate of uniform thickness is subject to pressure as shown in the figure below
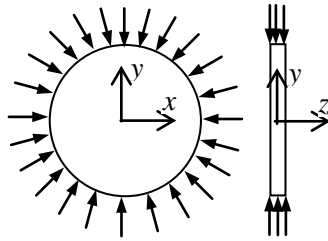
Under the assumption of plane stress, which one of the following is correct?

(A) Normal stress is zero in the z-direction
(B) Normal stress is tensile in the z-direction
(C) Normal stress is compressive in the z-direction
(D) Normal stress varies in the z-direction

Q.12   For laminar forced convection over a flat plate, if the free stream velocity increases by a factor of 2, the average heat transfer coefficient

(A) remains same   (B) decreases by a factor of $\sqrt{2}$

(C) rises by a factor of $\sqrt{2}$ (D) rises by a factor of 4

Q.13   The thermal efficiency of an air-standard Brayton cycle in terms of pressure ratio r_p and γ $(= c_p/c_v)$ is given by

(A) $1 - \dfrac{1}{r_p^{\gamma-1}}$ (B) $1 - \dfrac{1}{r_p^{\gamma}}$ (C) $1 - \dfrac{1}{r_p^{1/\gamma}}$ (D) $1 - \dfrac{1}{r_p^{(\gamma-1)/\gamma}}$

Q.14   For an incompressible flow field, $\vec{V}$, which one of the following conditions must be satisfied?

(A) $\nabla \cdot \vec{V} = 0$ (B) $\nabla \times \vec{V} = 0$ (C) $(\vec{V} \cdot \nabla)\vec{V} = 0$ (D) $\frac{\partial \vec{V}}{\partial t} + (\vec{V} \cdot \nabla)\vec{V} = 0$

Q.15   A pure substance at 8 MPa and 400 °C is having a specific internal energy of 2864 kJ/kg and a specific volume of 0.03432 m³/kg. Its specific enthalpy (in kJ/kg) is _____

Q.16   In a heat exchanger, it is observed that $\Delta T_1 = \Delta T_2$, where ΔT_1 is the temperature difference between the two single phase fluid streams at one end and ΔT_2 is the temperature difference at the other end. This heat exchanger is

(A) a condenser   (B) an evaporator
(C) a counter flow heat exchanger   (D) a parallel flow heat exchanger

Q.17   The difference in pressure (in N/m²) across an air bubble of diameter 0.001 m immersed in water (surface tension = 0.072 N/m) is _____

Q.18   If there are *m* sources and *n* destinations in a transportation matrix, the total number of basic variables in a basic feasible solution is

(A) $m + n$ (B) $m + n + 1$ (C) $m + n - 1$ (D) m

Q.19   A component can be produced by any of the four processes I, II, III and IV. The fixed cost and the variable cost for each of the processes are listed below. The most economical process for producing a batch of 100 pieces is

Process	Fixed cost (in Rs.)	Variable cost per piece (in Rs.)
I	20	3
II	50	1
III	40	2
IV	10	4

(A) I   (B) II   (C) III   (D) IV

Q.20   The flatness of a machine bed can be measured using

(A) Vernier calipers   (B) Auto collimator

(C) Height gauge   (D) Tool maker's microscope

Q.21   A robot arm PQ with end coordinates P(0,0) and Q(2,5) rotates counter clockwise about P in the XY plane by 90°. The new coordinate pair of the end point Q is

(A) (−2,5)   (B) (−5,2)   (C) (−5, −2)   (D) (2, −5)

Q.22   Match the Machine Tools (Group A) with the probable Operations (Group B):

Group A		Group B	
P:	Centre Lathe	1:	Slotting
Q:	Milling	2:	Counter-boring
R:	Grinding	3:	Knurling
S:	Drilling	4:	Dressing

(A) P-1, Q-2, R-4, S-3   (B) P-2, Q-1, R-4, S-3
(C) P-3, Q-1, R-4, S-2   (D) P-3, Q-4, R-2, S-1

Q.23   The following four unconventional machining processes are available in a shop floor. The most appropriate one to drill a hole of square cross section of 6 mm × 6 mm and 25 mm deep is

(A) Abrasive Jet Machining   (B) Plasma Arc Machining
(C) Laser Beam Machining   (D) Electro Discharge Machining

Q.24   The relationship between true strain (ε_T) and engineering strain (ε_E) in a uniaxial tension test is given as

(A) $\varepsilon_E = \ln(1 + \varepsilon_T)$ (B) $\varepsilon_E = \ln(1 - \varepsilon_T)$

(C) $\varepsilon_T = \ln(1 + \varepsilon_E)$ (D) $\varepsilon_T = \ln(1 - \varepsilon_E)$

Q.25   With respect to metal working, match Group A with Group B:

Group A	Group B
P: Defect in extrusion	I: alligatoring
Q: Defect in rolling	II: scab
R: Product of skew rolling	III: fish tail
S: Product of rolling through cluster mill	IV: seamless tube
	V: thin sheet with tight tolerance
	VI: semi-finished balls of ball bearing

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

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

Q. 26 – Q. 55 carry two marks each.

Q.26   An analytic function of a complex variable $z = x + i\,y$ is expressed as $f(z) = u(x, y) + i\,v(x, y)$, where $i = \sqrt{-1}$. If $u(x, y) = 2\,x\,y$, then $v(x, y)$ must be

(A) $x^2 + y^2 + $ constant   (B) $x^2 - y^2 + $ constant

(C) $-x^2 + y^2 + $ constant   (D) $-x^2 - y^2 + $ constant

Q.27
The general solution of the differential equation $\dfrac{dy}{dx} = \cos(x + y)$, with c as a constant, is

(A) $y + \sin(x + y) = x + c$ (B) $\tan\left(\dfrac{x + y}{2}\right) = y + c$

(C) $\cos\left(\dfrac{x + y}{2}\right) = x + c$ (D) $\tan\left(\dfrac{x + y}{2}\right) = x + c$

Q.28   Consider an unbiased cubic dice with opposite faces coloured identically and each face coloured red, blue or green such that each colour appears only two times on the dice. If the dice is thrown thrice, the probability of obtaining red colour on top face of the dice at least twice is _____

Q.29
The value of $\int\limits_{2.5}^{4} \ln(x)\,dx$ calculated using the Trapezoidal rule with five subintervals is _____

Q.30 The flexural rigidity (*EI*) of a cantilever beam is assumed to be constant over the length of the beam shown in figure. If a load *P* and bending moment *PL*/2 are applied at the free end of the beam then the value of the slope at the free end is
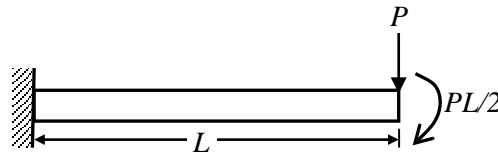
(A) $\dfrac{1}{2}\dfrac{PL^2}{EI}$ (B) $\dfrac{PL^2}{EI}$ (C) $\dfrac{3}{2}\dfrac{PL^2}{EI}$ (D) $\dfrac{5}{2}\dfrac{PL^2}{EI}$

Q.31 A cantilever beam of length, *L*, with uniform cross-section and flexural rigidity, *EI*, is loaded uniformly by a vertical load, *w* per unit length. The maximum vertical deflection of the beam is given by

(A) $\dfrac{wL^4}{8EI}$ (B) $\dfrac{wL^4}{16EI}$ (C) $\dfrac{wL^4}{4EI}$ (D) $\dfrac{wL^4}{24EI}$

Q.32 For the three bolt system shown in the figure, the bolt material has shear yield strength of 200 MPa. For a factor of safety of 2, the minimum metric specification required for the bolt is
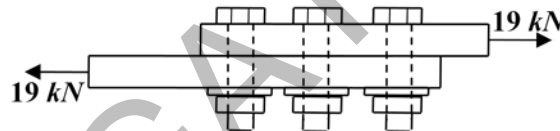

(A) M8   (B) M10   (C) M12   (D) M16

Q.33 Consider a flywheel whose mass *M* is distributed almost equally between a heavy, ring-like rim of radius *R* and a concentric disk-like feature of radius *R*/2. Other parts of the flywheel, such as spokes, etc, have negligible mass. The best approximation for α, if the moment of inertia of the flywheel about its axis of rotation is expressed as αMR^2, is _____

Q.34   What is the natural frequency of the spring mass system shown below? The contact between the block and the inclined plane is frictionless. The mass of the block is denoted by m and the spring constants are denoted by k_1 and k_2 as shown below.
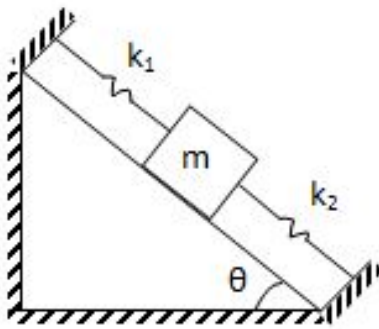

(A) $\sqrt{\dfrac{k_1 + k_2}{2m}}$ (B) $\sqrt{\dfrac{k_1 + k_2}{4m}}$ (C) $\sqrt{\dfrac{k_1 - k_2}{m}}$ (D) $\sqrt{\dfrac{k_1 + k_2}{m}}$

Q.35   A disc clutch with a single friction surface has coefficient of friction equal to 0.3. The maximum pressure which can be imposed on the friction material is 1.5 MPa. The outer diameter of the clutch plate is 200 mm and its internal diameter is 100 mm. Assuming uniform wear theory for the clutch plate, the maximum torque (in N.m) that can be transmitted is _____

Q.36   A truck accelerates up a 10° incline with a crate of 100 kg. Value of static coefficient of friction between the crate and the truck surface is 0.3. The maximum value of acceleration (in m/s^2) of the truck such that the crate does not slide down is _____

Q.37   Maximum fluctuation of kinetic energy in an engine has been calculated to be 2600 J. Assuming that the engine runs at an average speed of 200 rpm, the polar mass moment of inertia (in kg.m^2) of a flywheel to keep the speed fluctuation within ±0.5% of the average speed is _____

Q.38   Consider the two states of stress as shown in configurations I and II in the figure below. From the standpoint of distortion energy (von-Mises) criterion, which one of the following statements is true?
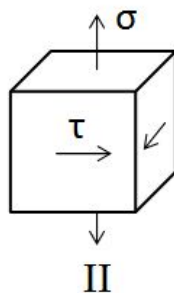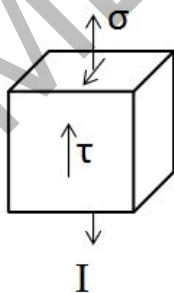

(A) I yields after II   (B) II yields after I
(C) Both yield simultaneously   (D) Nothing can be said about their relative yielding

Q.39   A rigid link PQ of length 2 m rotates about the pinned end Q with a constant angular acceleration of 12 rad/s^2. When the angular velocity of the link is 4 rad/s, the magnitude of the resultant acceleration (in m/s^2) of the end P is _____

Q.40   A spur pinion of pitch diameter 50 mm rotates at 200 rad/s and transmits 3 kW power. The pressure angle of the tooth of the pinion is 20°. Assuming that only one pair of the teeth is in contact, the total force (in newton) exerted by a tooth of the pinion on the tooth on a mating gear is _____

Q.41   A spherical balloon with a diameter of 10 m, shown in the figure below is used for advertisements. The balloon is filled with helium (R_{He} = 2.08 kJ/kg.K) at ambient conditions of 15°C and 100 kPa. Assuming no disturbances due to wind, the maximum allowable weight (in newton) of balloon material and rope required to avoid the fall of the balloon (R_{air} = 0.289 kJ/kg.K) is _____
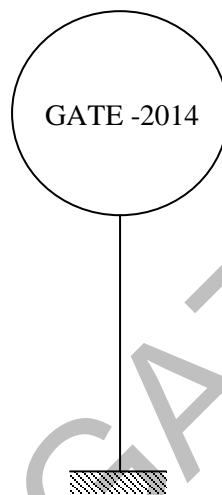
Q.42   A hemispherical furnace of 1 m radius has the inner surface (emissivity, $\varepsilon = 1$) of its roof maintained at 800 K, while its floor ($\varepsilon = 0.5$) is kept at 600 K. Stefan-Boltzmann constant is 5.668×10^{-8} W/m^2.K^4. The net radiative heat transfer (in kW) from the roof to the floor is _____

Q.43   Water flows through a 10 mm diameter and 250 m long smooth pipe at an average velocity of 0.1 m/s. The density and the viscosity of water are 997 kg/m^3 and 855×10^{-6} N.s/m^2, respectively. Assuming fully-developed flow, the pressure drop (in Pa) in the pipe is _____

Q.44   A material P of thickness 1 mm is sandwiched between two steel slabs, as shown in the figure
       below. A heat flux 10 kW/m^2 is supplied to one of the steel slabs as shown. The boundary
       temperatures of the slabs are indicated in the figure. Assume thermal conductivity of this steel is 10
       W/m.K. Considering one-dimensional steady state heat conduction for the configuration, the
       thermal conductivity (k, in W/m.K) of material P is _____
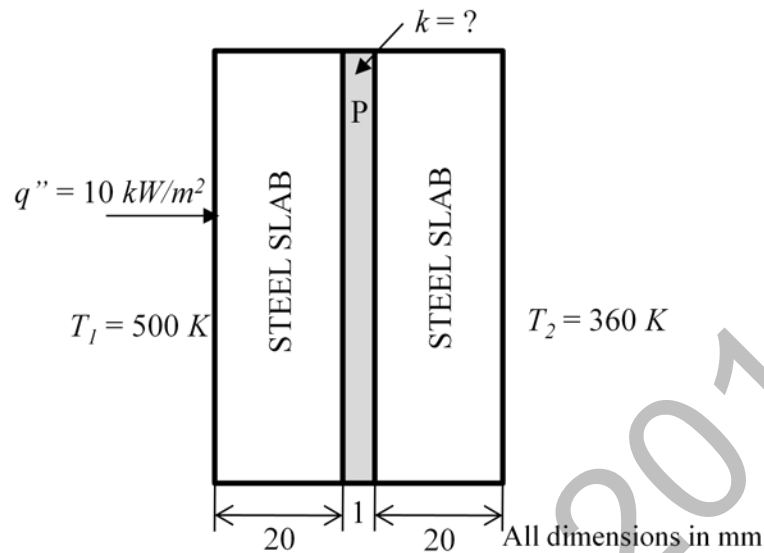
Q.45   Consider laminar flow of water over a flat plate of length 1 m. If the boundary layer thickness at a
       distance of 0.25 m from the leading edge of the plate is 8 mm, the boundary layer thickness
       (in mm), at a distance of 0.75 m, is _____

Q.46   In an ideal Brayton cycle, atmospheric air (ratio of specific heats, c_p/c_v = 1.4, specific heat at
       constant pressure = 1.005 kJ/kg.K) at 1 bar and 300 K is compressed to 8 bar. The maximum
       temperature in the cycle is limited to 1280 K. If the heat is supplied at the rate of 80 MW, the mass
       flow rate (in kg/s) of air required in the cycle is _____

Q.47   Steam at a velocity of 10 m/s enters the impulse turbine stage with symmetrical blading having
       blade angle 30°. The enthalpy drop in the stage is 100 kJ. The nozzle angle is 20°. The maximum
       blade efficiency (in percent) is _____

Q.48   In a concentric counter flow heat exchanger, water flows through the inner tube at 25°C and leaves
       at 42°C. The engine oil enters at 100°C and flows in the annular flow passage. The exit temperature
       of the engine oil is 50°C. Mass flow rate of water and the engine oil are 1.5 kg/s and 1 kg/s,
       respectively. The specific heat of water and oil are 4178 J/kg.K and 2130 J/kg.K, respectively. The
       effectiveness of this heat exchanger is _____

Q.49 A heat pump with refrigerant R22 is used for space heating between temperature limits of −20°C and 25°C. The heat required is 200 MJ/h. Assume specific heat of vapour at the time of discharge as 0.98 kJ/kg.K. Other relevant properties are given below. The enthalpy (in kJ/kg) of the refrigerant at isentropic compressor discharge is _____

Saturation temperature	Pressure	Specific enthalpy		Specific entropy	
T_{sat} (°C)	P (MN/m²)	h_f (kJ/kg)	h_g (kJ/kg)	s_f (kJ/kg.K)	s_g (kJ/kg.K)
−20	0.2448	177.21	397.53	0.9139	1.7841
25	1.048	230.07	413.02	1.1047	1.7183

Q.50 A project has four activities P, Q, R and S as shown below.

Activity	Normal duration (days)	Predecessor	Cost slope (Rs./day)
P	3	-	500
Q	7	P	100
R	4	P	400
S	5	R	200

The normal cost of the project is Rs. 10,000/- and the overhead cost is Rs. 200/- per day. If the project duration has to be crashed down to 9 days, the total cost (in Rupees) of the project is _____

Q.51 Consider the following data with reference to elementary deterministic economic order quantity model

Annual demand of an item	100000
Unit price of the item (in Rs.)	10
Inventory carrying cost per unit per year (in Rs.)	1.5
Unit order cost (in Rs.)	30

The total number of economic orders per year to meet the annual demand is _____

Q.52 For the CNC part programming, match Group A with Group B:

Group A	Group B
P: circular interpolation, counter clock wise	I: G02
Q: dwell	II: G03
R: circular interpolation, clock wise	III: G04
S: point to point countering	IV: G00

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

Q.53 A mild steel plate has to be rolled in one pass such that the final plate thickness is 2/3rd of the initial thickness, with the entrance speed of 10 m/min and roll diameter of 500 mm. If the plate widens by 2% during rolling, the exit velocity (in m/min) is _____

Q.54 A hole of 20 mm diameter is to be drilled in a steel block of 40 mm thickness. The drilling is performed at rotational speed of 400 rpm and feed rate of 0.1 mm/rev. The required approach and over run of the drill together is equal to the radius of drill. The drilling time (in minute) is

(A) 1.00   (B) 1.25   (C) 1.50   (D) 1.75

Q.55 A rectangular hole of size 100 mm × 50 mm is to be made on a 5 mm thick sheet of steel having ultimate tensile strength and shear strength of 500 MPa and 300 MPa, respectively. The hole is made by punching process. Neglecting the effect of clearance, the punching force (in kN) is

(A) 300   (B) 450   (C) 600   (D) 750

END OF THE QUESTION PAPER