SAMPLE QUESTIONS OF ENGINEERING SCIENCES

The question paper of Engineering Sciences will comprise of three parts viz. Part A, Part B and Part C. Part A which contains 20 questions (15 to be answered) will be common to all subject of science and engineering. Part B will have 25 questions (20 to be answered) from Mathematics and Engineering Aptitude. In Part C there will be 7 subject-areas with 10 questions in each subject. The candidates will be required to answer any 20 questions out of 70. For more details please visit the scheme of examination and syllabus which are already available on our web.

Here are some sample questions of Part B and Part C.

PART B

MATHEMATICS AND ENGINEERING APTITUDE

Q.1 The determinant of an orthogonal matrix of size 5 × 5 can be:

(1) –1 (2) 0 (3) 5 (4) 25

Q.2 Let $y(x)$ be a solution of the differential equation $\frac{dy}{dx} = y^2 x\, dy$. If $y(1) = 1$ then $y(x)$ satisfies the equation

(1) $x^2 - 2y + 1 = 0$ (2) $x^2y - 3y + 2 = 0$
(3)) $x^2y - 1 = 0$ (4) $\log(y)/x^2 = 0$

Q.3 Let S be the sphere $x^2 + y^2 + (z - 1)^2 = 9$ and $F : S - R^3$ be such that $F(x, y, z) = xi + yj + (z - 1)k$ for all $(x, y, z) \in S$. Let $\hat{n}$ denote the unit outward normal to the surface S. Then the value of the surface integral $\iint_S F.\hat{n}\, d\sigma$ is

(1) 36π (2) 54π (3) 72π (4) 108π

Q.4 Let S be the closed contour $\{z \in \mathbb{C} : |z| = 1\}$. Then the value of the integral $\frac{1}{2\pi i}\oint_S \frac{1}{z} dz$ is

(1) –1 (2) 0 (3) 1 (4) $2\pi i$

Q.5 The value of $\lim_{x\to 0} \frac{\tan x}{5x}$ is

(1) 1 (2) 0 (3) ∞ (4) 0.2

Q.6 The electric field $\vec{E}$ (in volts/metre) at the point (1, 1, 0) due to a point charge of + 1uC located at (-1, 1, 1) (coordinates in metres) is

(1) $\frac{10^{-6}}{20\sqrt{5}\,\pi\varepsilon_0}(2i - k)$ (2) $\frac{10^{-6}}{20\pi\varepsilon_0}(2i - k)$

(3) $\frac{-10^{-6}}{20\sqrt{5}\,\pi\varepsilon_0}(2\mathrm{i}-\mathrm{k})$ (4) $\frac{-10^{-6}}{20\,\pi\varepsilon_0}(2\mathrm{i}-\mathrm{k})$

Q.7 Given two coupled inductors L_1 and L_2, their mutual inductance M satisfies

(1) $M=\sqrt{L_1^2}$ (2) $M > (L_1+L_2)/2$ (3) $M > \sqrt{L_1L_2}$ (4) $M \le \sqrt{L_1L_2}$

Q.8 An amplitude modulator has modulating input $m(t)$ and carrier $c(t)$ given as
$m(t) = \cos(100\pi t) + \sin(4000\pi t)$, $c(t) = \sin(2\pi f t)$, where $f = 10$ MHz.
An envelope detector used for demodulation of the output signal to recover the modulating input should have time constant τ given as

(1) 0.1 μs << τ (2) τ << 0.5 ms
(3) 0.1 μs << τ << 0.5 ms (4) 0.1 μs << τ << 20 ms

Q.9 A digital-to-analog converter has output range of $\pm$ 3.5 V and a resolution of approximately 7 mV. Number of bits in its digital input is

(1) 8 (2) 9 (3) 10 (4) 11

Q.10 The following FET amplifier(s) has (have) in-phase relationship between input and output

(1) Common source (2) Common gate
(3) Common drain (4) Common gate, Common drain

Q.11 Face centered cubic structure exhibits

(1) 4 octahedral sites and 3 slip systems
(2) 12 octahedral sites and 12 slip systems
(3) 4 octahedral sites and 12 slip systems
(4) 12 octahedral sites and 48 slip systems

Q.12 The magnitude of activation energy of volume (Qv), grain boundary (Qgb) and surface (Qs) diffusion are in the order

(1) Qgb > Qs> Qv (2) Qs > Qgb> Qv
(3) Qv > Qgb> Qs (4) Qgb > Qs> Qs

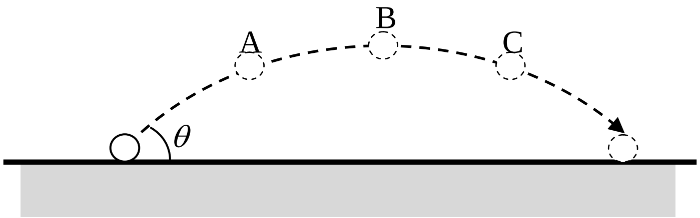
Q.13 A static fluid can have

(1) non-zero normal and shear stress
(2) negative normal stress and zero shear stress
(3) positive normal stress and zero shear stress
(4) zero normal stress and non-zero shear stress

Q.14 In a two dimensional flow in x-y plane, if $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$ then the fluid element will undergo

(1) translation only
(2) translation and rotation
(3) translation and deformation
(4) rotation and deformation

Q.15 A cannon ball of mass m is shot at an angle θ from the horizontal on a level surface at a speed V as shown. Assume that there is no air drag on the cannon ball. What are the directions of accelerations on the cannon ball at locations A, B and C shown in the Figure?



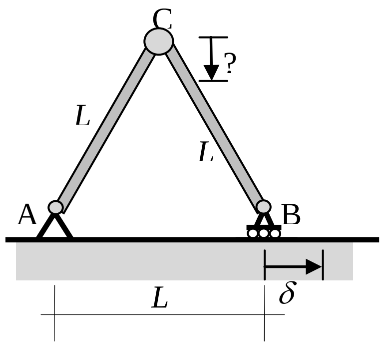
(1) A: Upwards
B: Neutral
C: Downwards

(2) A: Tangential
B: Tangential
C: Tangential

(3) A: Downwards
B: Downwards
C: Downwards

(4) A: Upwards
B: Upwards
C: Upwards

Q.16 A pinned two-bar mechanism shown is constrained by a pin-joint at A and a roller moving horizontally at B. The lengths of the bars AC and BC are each L. If the roller B is moved horizontally away from A by a small amount δ, what is the magnitude of the downward movement of joint C?



(1) $2\sqrt{3}\delta$
(2) $\frac{2}{\sqrt{3}}\delta$
(3) $\frac{1}{\sqrt{3}}\delta$
(4) $\frac{1}{2\sqrt{3}}\delta$

Q.17 Air is compressed from an initial state of 100 kPa and 17°C to a final state of 600 kPa and 57°C. R_{air} = 0.287 kJ/kgK, $C_{v,air}$ = 0.718 kJ/kgK. The entropy change of air during the process in kJ/kgK is

(1) 0.385
(2) - 0.385
(3) 0.421
(4) - 0.421

Q.18 In a perfectly insulated, steady flow type of an electrical water heater, 0.1 kg/s of liquid water is heated from 27^{o}C to 60^{o}C. Assume water to be incompressible with a specific heat of 4.2 kJ/kgK and the surrounding temperature to be equal to 27^{o}C. The second law efficiency of the water heater is

(1) 5.13 % (2) 34.67 % (3) 94.87 % (4) 100 %

PART C

SAMPLE QUESTIONS
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COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

1 . In the heap shown in Figure 1, inserting 80 and deleting 25 results as shown in Figure 2. The values in nodes marked X and Y are

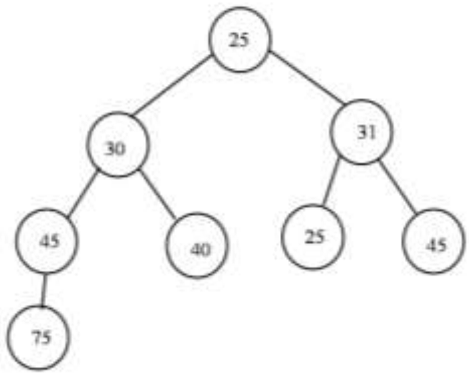


Figure 1

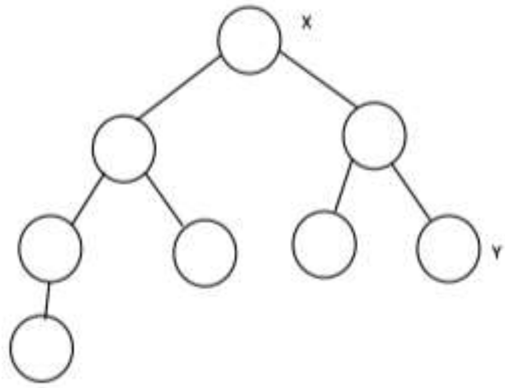


Figure 2

(1) X = 35, Y = 80 (2) X = 50, Y = 75
(3) X = 80, Y = 50 (4) X = 30, Y = 80

2. The complexity of PUSH and POP when implementing a STACK ADT in a singly list are

(1) PUSH = Ω(n), POP = 0(n). (2) PUSH = 0(1), POP = Ω(n).

(3) PUSH = 0(1), POP = 0(1). (4) PUSH = Ω(n), POP = Ω(n)

3. Given a single transistor dynamic memory cell, assume that the capacitance is 50 femtofarads (femto = 10^{-15}), leakage current through the transistor is about 9 picoamperes (pico=10^{-12}). The voltage across the capacitor when it is fully charged is equal to 4.5 volts. The cell must be refreshed before this voltage drops below 3 volts. Estimate the minimum refresh rate:

(1) 8 milliseconds (2)) 80 milliseconds (3) 8 seconds (4) 80 seconds

4. What is the effective access time for demand-paged memory if the memory access time is 100 nanoseconds with the probability of a page fault of 0.01, and page fault service time being 10 milliseconds?

(1) 100099 nanoseconds
(2) 9999 nanoseconds
(3) 100 nanoseconds
(4) 0.1 nanoseconds

ELECTRICAL SCIENCES

5 . A 400 V, 50 Hz, 1480 rpm, 3-phase squirrel cage induction motor having negligible starter series impedance is found to run at a speed of 1520 rpm while driving a certain load while rated voltage and frequency are applied to its stator terminals. The rotational losses of the machine are negligible. The machine is operating under

(1) motoring mode while developing rated torque
(2) regenerative mode while developing half the rated negative torque
(3) regenerative mode while developing rated negative torque
(4) unstable mode of operation

6 . An R-L load is receiving power from a source through a feeder having negligible impedance. The load voltage is V_L and the real power supplied by the source is P_S. Now, a capacitor is connected across the load. The load voltage and the real power supplied by the source in the presence of capacitor are V_{L1} and P_{S1} respectively. Which one of the following statement is true?

(1) $V_{L1} = V_L$ and $P_{S1} = P_S$
(2) $V_{L1} > V_L$ and $P_{S1} < P_S$
(3) $V_{L1} < V_L$ and $P_{S1} < P_S$
(4) $V_{L1} < V_L$ and $P_{S1} > P_S$

ELECTRONICS

7 . An op amp is powered by $\pm$12 V supply. It is connected as inverting amplifier with gain of -10. It has input of +10 mV and input offset voltage of 5 mV. The output voltage is

(1) –150 mV
(2) – 50 mV
(3) –155 mV or -45 mV
(4) –150 mV or -50 mV

8 . A processor has an instruction XOR R1, R2. It performs Exclusive OR operation on registers R1 and R2 and stores the result in register R1. Starting with certain contents in the two registers, the following sequence of operations are executed

XOR R2, R1
XOR R1, R2
XOR R2, R1

The following is TRUE about the register contents

(1) Content of R2 is sum of the original contents of R1 and R2.
(2) Content of R2 is half of the sum of the original contents of R1 and R2.
(3) Contents of R1 and R2 have been swapped.
(4) None of the above.

9 . A discrete-time causal stable system has impulse response

$$h_1(n) = \delta(n) - a\delta(n\text{-}1), \text{ with } |a| > 1.$$

It is to be cascaded with a second discrete-time causal stable system with impulse response $h_2(n)$ such that the cascaded system is a causal stable all-pass system. We should have

(1) $h_2(n) = -\delta(n) + a\delta(n-1)$ (2) $h_2(n) = a\delta(n-1)$
(3) $h_2(n) = a^{-n}u(n)$ (4) $h_2(n) = \delta(n) - a^{-n}u(n)$

MATERIALS SCIENCE

10 . Match the following

P.	Fatigue	1.	Dimple
Q.	Brittle	2.	Crack branching
R.	Ductile	3.	Striations
S.	Stress corrosion	4.	Cleavage

(1) P – 3, Q – 4, R – 1, S – 2 (2) P – 4, Q – 2, R – 3, S – 1
(3) P – 4, Q – 4, R – 2, S – 1 (4) P – 4, Q – 2, R – 1, S – 3

11 . A point in a structural component experience $\sigma_{II} = \sigma_{III} = 100$ MPa. If the yield strength of the material is 150 MPa, the magnitude of σ_I (in MPa) that would caused yielding at the point under multiaxial state of stress is:

(1) 100 (2) 150 (3) 200 (4) 250

FLUID MECHANICS

12 . Fluid flows steadily through a converging nozzle of length L. Flow can be approximated as one-dimensional such that the axial velocity varies linearly from entrance to exit. The velocities at entrance and exit are V_0 and $4V_0$ respectively. The acceleration of a particle flowing through the nozzle is given by

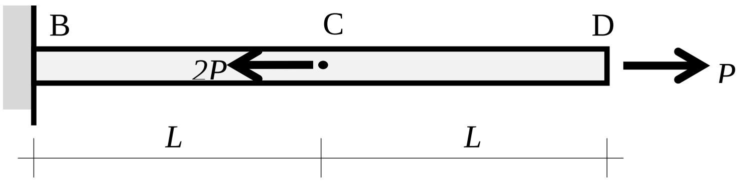
(1) $\frac{V_0^2}{L}\left(1+\frac{3x}{L}\right)$ (2) $\frac{2V_0^2}{L}\left(1+\frac{3x}{L}\right)$ (3) $\frac{3V_0^2}{L}\left(1+\frac{3x}{L}\right)$ (4) $\frac{4V_0^2}{L}\left(1+\frac{3x}{L}\right)$

13 . The velocity profile of a fully developed laminar flow in a straight circular pipe is given by $u = -\frac{R^2}{4\mu}\frac{dp}{dx}\left(1-\frac{r^2}{R^2}\right)$, where $\frac{dp}{dx}$ is a constant, R is the radius of the pipe and r is the radial distance from the centre of the pipe. The average velocity of fluid in the pipe is

(1) $-\frac{R^2}{\mu}\frac{dp}{dx}$ (2) $-\frac{R^2}{2\mu}\frac{dp}{dx}$ (3) $-\frac{R^2}{4\mu}\frac{dp}{dx}$ (4) $-\frac{R^2}{8\mu}\frac{dp}{dx}$

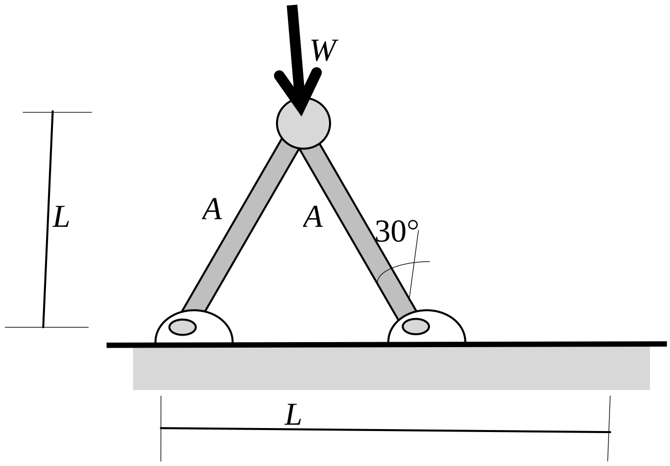
SOLID MECHANICS

14 . A bar of length *2L* shown in the figure is constrained at end B and subjected to loads at points C and D. The area of cross-section is *A* and the Modulus of Elasticity is *E*. What is the total elongation in the bar at point D?



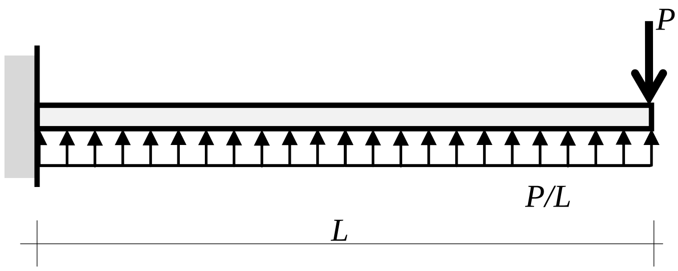
(1) $-\frac{PL}{EA}$ (2) $-\frac{3PL}{EA}$ (3) $+\frac{PL}{EA}$ (4) 0

15 . A pin-jointed two-bar assembly is held at supports B and D. Both bars are of the same cross-sectional area *A* and Modulus of Elasticity *E*. What is the vertical displacement of joint C under the application of force *P* at point C?



(1) $\frac{PL}{2EA}$ (2) $\frac{2PL}{3EA}$ (3) $\frac{PL}{EA}$ (4) $\frac{3PL}{2EA}$

16 . A cantilever beam shown in the figure is subjected to a downward load *P* at the free end and an upward uniformly distributed load (intensity *P/L* per init length) throughout the length of the beam. The beam cross-section has a moment of inertia *I*. The material of the beam has Modulus of Elasticity *E*. What is the elastic flexural deflection Δ at the free end of the cantilever beam?



(1) $\frac{5PL^3}{24EI}$ (2) $\frac{3PL^3}{8EI}$ (3) $\frac{11PL^3}{24EI}$ (4) $\frac{2PL^3}{3EI}$

THERMODYNAMICS

17 . In a laboratory test, a well insulated horizontal nozzle has a flow of steam at a mass flow rate of 0.2 kg/s. Steam enters the nozzle at 1 MPa, 400 ^{o}C with negligibly small kinetic energy. The condition at nozzle outlet is measured to be 500 kPa and 350 ^{o}C. Steam properties: specific enthalpy at inlet = 3263.88 kJ/kg, at exit = 3167.65 kJ/kg. The exit velocity of steam in m/s is

(1) 13.87 (2) 43.87 (3) 138.7 (4) 438.7

18 . Air contained in a frictionless piston-cylinder arrangement interacts with the surroundings and undergoes an isobaric process from an initial state of 300 K and 0.01 m^3 to a final state at which the volume is 0.03 m^3. Assume air to behave as an ideal gas with a gas constant of 0.287 kJ/kgK and a C_v value of 0.767 kJ/kgK. If the work transferred during this process is 10 kJ, the heat transferred during the process is

(1) 16.72 kJ from surroundings to the air
(2 36.72 kJ from air to the surroundings
(3) 36.72 kJ from surroundings to the air
(4) 26.72 kJ from surroundings to the air

Engineering Sciences candidates may use Scientific Calculators without data connectivity