PGAT-MECHANICAL ENGINEERING

1. A velocity field is represented by $V = 5x^3 i - 15x^2 y j + t k$, where i, j, k are the unit vectors in x, y and z direction. The divergence of the velocity field is:
   (a) $5x^3 - y + t$
   (b) 0
   (c) $15x^2 - y + 0$
   (d) $5x^3 - 15y$

2. A liquid is half filled in a cylinder of radius R. The cylinder rotates (ω) about its central axis so that the liquid does not spill out of it. The pressure at the bottom of the cylinder wall is p2 and at the axis is p1. The relation between p2, p1, ω, R is:
   (a) $p_2 - p_1 = \rho \omega^2 R^2 / 2$
   (b) $p_2 - p_1 = \rho \omega^2 R^2$
   (c) $p_2 - p_1 = \rho \omega R / 2$
   (d) None of the above

3. A liquid is half filled in a cylinder of radius R. The cylinder rotates (ω) about its central axis so that the liquid does not spill out of it. The pressure is higher near the wall compared to the center because
   (a) Viscosity of fluid causes it
   (b) Atmospheric pressure causes it
   (c) Balancing force is caused due to rotational component of velocity
   (d) None of the above

4. A reservoir has a head of 40m and the channel from the reservoir can allow a flow of 34m³/s of water to a turbine which can rotate at 150RPM. Assuming density of water to be 1000 kg/m³, the power output of the turbine can be:
   (a) 21.36MW
   (b) 1.36MW
   (c) 2.13MW
   (d) 13.34 MW

5. A very long pipe is used to pump water from a reservoir to another place (inlet and outlet are at the same level). If the velocity head is negligible in the system, then the head developed by the pump is: (L =length of pipe, d=diameter of pipe, v=avg velocity of fluid in pipe and f=Darcy friction factor)
   (a) $h_p = f L v^2 / 2dg$
   (b) $h_p = L/2000$
   (c) $h_p = Lv^2 / 2dg$
   (d) None of the above

6. A steel block of specific gravity 7.85 is floating at a mercury water interface. The specific gravity of mercury is 13.57. The steel block has a uniform cross section of S and a height of $a+b$. The portion b of the steel block is inside mercury and the portion a of the block is inside water. The ratio of a/b is:
   (a) .544
   (b) .578
   (c) 1.72
   (d) 0.835

7. A gas in a cylinder piston machine is compressed form an initial state of $.3m^3$ to a final state of $.15m^3$ while the pressure remains constant at 0.1MPa. There is a heat transfer of 25kJ of heat from the gas during the process. The change in internal energy of the gas is:
   (a) 35kJ
   (b) -10kJ
   (c) 10kJ
   (d) 40kJ

8. When a system is taken from a to c along the path abc, 84kJ of heat flows into the system and the system does 40kJ of work. If the system is taken from a to c through the path adc where the system has done 20kJ of work then how much of heat will flow in to the system?
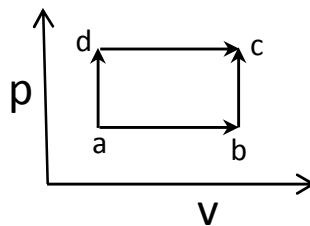

   (a) 0
   (b) -24
   (c) 64kJ
   (d) 24

9. One kg of water at 10°C is brought into contact with a reservoir at 100°C. When the water temperature has become 100°C what is the entropy change of water? Cp=4.18kJ/kg-K
   (a) 1.15kJ/K
   (b) 9.62kJ/K
   (c) 0.50 kJ/K
   (d) None of the above

10. For the same pressure rise, compressing steam in vapor form or liquid form would take more work?
   (a) Cannot be told
   (b) Compression in both form would take the same work
   (c) Vapor form compression would take more work
   (d) Liquid form compression would take more work

11. In thermal power plants the condenser pressure is kept much below the atmospheric pressure because
   (a) Less blade erosion is desired in the turbine
   (b) More work can be obtained from the turbine
   (c) Saturation pressure of steam corresponding to available cooling water temperature is much lower than the atmospheric pressure
   (d) The condenser may fail if low pressure is not maintained in it.

12. On a p-v diagram two processes are shown. Through point -1 the process of $pv^\gamma = c$ passes and at point-1 p=200kpa, v=0.2m³ and γ =1.4. There is another constant temperature process for which $pv = RT$ and these two processes intersect at point '2'. What is the volume at state 2 if R=.287 kJ/kg-K?
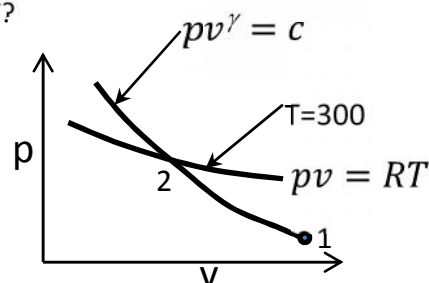
(a) 0.294m³

(b) .00294m³

(c) 0.568m³

(d) 0.0294m³

13. On a p-v diagram two processes are shown. Through point -1 the process of $pv^\gamma = c$ passes and at point-1 p=200kpa, v=0.2m³ and γ =1.4. There is another constant temperature process for which $pv = RT$ and these two processes intersect at point '2'. R=.287 kJ/kg-K What is the pressure at state 2 :
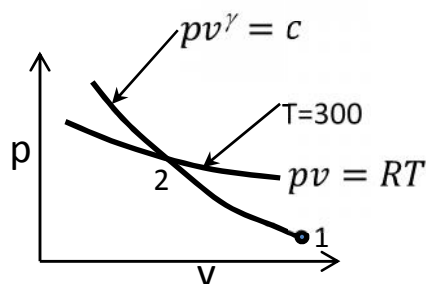
(a) 2926kPa

(b) 292.6 kPa

(c) 151.6 kPa

(d) 595 kpa

14. In a double pipe heat exchanger brine solution is heated from 8C to 14C by water entering at 55C and leaving at 40C at a rate of 0.18kg/s. The LMTD for parallel flow arrangement is:

(a) 32.3C

(b) 36.3C

(c) 35.4C

(d) 38.6C

15. In a double pipe heat exchanger brine solution is heated from 8C to 14C by water entering at 55C and leaving at 40C at a rate of 0.18kg/s. The LMTD for counter flow arrangement is:

(a) 34.3C

(b) 36.31C

(c) 35.4C

(d) 38.2C

16. A plane slab of 1m length has uniform volumetric heat generation (40W/m³) in it. The conductivity of the slab is 1 W/m-K. The left end of the slab is maintained at 10C and so also the right end. What is the temperature of the slab at x=0.5m assuming one-D steady state heat flow in the slab?

(a) 15C

(b) 12C

(c) 20C

(d) 18C

17. A plane slab of 1m length has uniform volumetric heat generation ($40W/m^3$) in it. The conductivity of the slab is 1 W/m-K. The left end of the slab is maintained at 10C and so also the right end. What is the temperature of the slab at x=0.5m assuming one-D steady state heat flow in the slab?, the temperature gradient at x =0 and x=L are:
   (a) -10, 10
   (b) 10, -10
   (c) -20, 20
   (d) 20, -20

18. A small metallic sphere of mass 1 kg, specific heat 1 J/kg-K has an initial temperature of 50C. It is placed in an ambient of 10C where the heat transfer coefficient from the sphere to the ambient is 10 W/m²-K. If the surface area of the sphere is .01m² and the conductivity of the sphere is so high that the sphere can be assumed to be in a fixed temperature at any time, then what would be the temperature of the sphere after 20s it is placed in the ambient?
   (a) 14.4C
   (b) 16.6C
   (c) 15.4C
   (d) 13.6C

19. A small metallic sphere of mass 1 kg, specific heat 1 J/kg-K has an initial temperature of 50C. It is placed in an ambient of 10C where the heat transfer coefficient from the sphere to the ambient is 10 W/m²-K. If the surface area of the sphere is .01m² and the conductivity of the sphere is so high that the sphere can be assumed to be in a fixed temperature at any time, then what would be the temperature of the sphere after 20s it is placed in the ambient? The value of dT/dt for the sphere at time t = 0 is:
   (a) -3 C/s
   (b) -4 C/s
   (c) 4 C/s
   (d) 3 C/s

20. A straight circular pipe of cross sectional area .01m² is having a steady flow of fluid in it. A certain section of the pipe is having a momentum influx of 1 kg-m/s² and efflux of 0.9kg-m/s². If that section has a pressure drop of 1 Pa then what is the shear force over that section?
   (a) 0.11 N
   (b) 0.09 N
   (c) -.09 N
   (d) -.11 N

21. A beam is statically indeterminant if there is/are more than equal to the following number of reactions.
(A) zero
(B) Two
(C) Three
(D) Infinite

22. The minimum number of strain gauges required to completely determine the biaxial state of stress in a structural member is

(A) 2
(B) 3
(C) 4
(D) 6

23. The ratio of longitudinal to circumferential stress in a thin walled pressure spherical vessel is
(A) 1
(B) 2
(C) 3
(D) 4

24. The Sommerfeld Number used in the design of journal bearing is not depended on the following
(A) Viscosity of the oil
(B) Diameter of the Journal
(C) Length of the bearing
(D) Rotational speed of the journal

25. The stress in a tooth of a spur gear in operation is a maximum at its
(A) Tip
(B) Root
(C) Middle
(D) None of the above

26. The deflection of a cantilever beam due to a transverse load at its free ened is proportional to
(A) the square of the length of the beam
(B) the cube of the length of the beam
(C) the modulus of Elasticity of the beam material
(D) the width of the beam

27. The dimension of elastic strain is
(A) $M^1 L^{-1} T^{-2}$
(B) $M^1 L^1 T^{-2}$
(C) $M^0 L^1 T^0$
(D) None of the above

28. In a thick cylinder subjected to internal pressure. The stress is maximum at its
(A) inner radius
(B) outer radius
(C) Middle point between inner and outer radius
(D) Uniform throughout the thickness of the wall

29. A prismatic bar is subjected to an axial tension will fail in shear in the following direction
(A) Axial direction
(B) At an angle of 22.5^0 to the axial direction
(C) At an angle of 45^0 to the axial direction

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(D) In the normal direction

30. A dynamometer is used to measure
(A) Force
(B) Speed
(C) Power
(D) Stress

31. A cycloid is the locus of a point on the circumference of a circle which rolls without slipping along a
(A) Straight Line
(B) Ellipse
(C) Circle
(D) Arc

32. Modulus of Resilience is
(A) an index of elasticity
(B) the property to store energy
(C) the property to resist impacts
(D) an index of compressibility

33. Which of the following is an anti-friction bearing
(A) Needle Bearing
(B) Bush Bearing
(C)Hydrostatic bearing
(D) Journal Bearing

34. Lewis equation in gears is used to determine
(A) Tensile stress
(B) Compressive stress in bending
(c)Contact stress
(D) Shear stress

35.   A long structural column fails predominantly by
(A) Bending
(B) Crushing
(C) Buckling
(D) Shearing

36. In a single degree undamped system at resonance the phase angle between the excitation and response changes by
(A) 0^0
(B) 45^0
(C) 90^0
(D) 180^0

37. If a pressure P is applied on a clutch having a sliding velocity v, then while designing the clutch for uniform wear the following is true
(A) P= constant
(B) v=constant
(C) Pv =constant
(D) Pv^2= constant

38. Which of the following screw thread is adopted for power transmission in either direction
(A) Acme threads
(B) Sqaure threads
(C) Buttress threads
(D) Mulitple threads

39. The maximum shear stress theory is used for
(A) brittle materials
(B) ductile materials
(C) Plastic materials
(D) Non-ferrous materials

40. For a simply supported beam having a transverse load applied at the center the bending moment will be
(A) minimum at the supports
(B) Minimum at the center
(C) Maximum at the supports
(D) Minimum and maximum could be anywhere along the length

41. What is a benefit of "just-in-time" production in automotive industry?

   (a) there will be no need for job scheduling
   (b) high quality parts produced at low cost
   (c) inventory carrying cost is higher compared to conventional method
   (d) there will no need for jigs and fixtures in the plant.

42. A Ø40 mm drilled hole was fabricated by using a lathe machine, and the diameter was measured by three vernier caliper three times by each. The measurements by caliper A are 39.98mm, 41.05mm and 39.96mm, and similarly measurements by caliper B is 39.94mm, 39.93mm and 39.94mm, and by caliper C is 40.05mm, 41.15mm and 39.95mm. Which is a more precise caliper for measurement?

   (a) caliper A
   (b) caliper B
   (c) none
   (d) both

43. In a machining operation, doubling the cutting speed reduces the tool life to 1/8th of the original value. What is the exponent "n" in Taylor's tool life equation V.T^n = C?

a. 1/2

***b.* 1/3**

c. 1/4

d. 1/8

44. When do discontinuous chips occur?

a. turning brittle workpiece metal

b. turning ductile workpiece metal

c. high rake angles in the cutting tool

d. turning workpiece materials that does not have hard inclusions/impurities.

45. A cutting tool can never have its-----.

a. Rake angle- positive

b. Clearance angle- positive

c. Rake angle- negative

d. Clearance angle- negative

46. What is the unit of feed rate in turning operation?

a. mm/stroke

b. mm/min

c. mm/revolution

d. non-dimensional quantity

47. Which of the following mechanism is used to accomplish the reciprocation of cutting tool in shaping machine?

a. Rack-pinion mechanism

b. Cam & cam follower mechanism

c. Crank & connecting rod mechanism

d. Oscillating lever mechanism

48. Which is a process capability of sand casting process among the following?

   (a) The casting will have excellent surface finish with dimensional accuracy
   (b) Relatively complicated components can be produced without too high initial cost
   (c) The casting components are completely free from defects like inclusions, sand burns and porosity
   (d) High strength components like crane hooks, shafts and gears can be manufactured by sand casting process.

49. In foundry, the basic parameters controlling the properties of molding sand are refractoriness, permeability, green strength, dry strength and collapsibility. Which among the following options is recommended?

(a) good permeability and high collapsibility.

(b) high green strength but low dry strength.

(c) high dry strength but low green strength.

(d) good permeability, high refractoriness but low collapsibility.

50. In Caine's formula $X = \frac{a}{Y-b} + c$ is used for designing the feeder (riser), what do X and Y represent?
   (a) Freezing ratio and volume ratio.
   (b) Shrinkage ratio and draft.
   (c) Shrinkage ratio and volume ratio.
   (d) Freezing ratio and draft.

51. Which combination will be more preferable as tool and work material for ultrasonic machining (USM)?
   a) Steel and copper
   b) Ceramics and copper
   c) Steel and glass
   d) Glassfibres and brass

52. What is the mechanism of material removal in electrical discharge machining (EDM) process?
   a) Cavitations and evaporation
   b) Melting and evaporation
   c) Erosion and cavitation
   d) Melting and corrosion

53. Material removal rate in electrochemical machining (ECM) depends on-----.
   a) Atomic weight and valiancy.
   b) Specific heat and heat conductivity.
   c) Material strength and hardness.
   d) Conductivity and impedance.

54. Which is a method to reduce the roll forces during cold rolling?
(a) increasing the friction between the roller and the strip.
(b) applying the front tension and back tension to the strip during rolling.
(c) using larger roller diameter to reduce the contact area.
(d) taking larger reduction per pass to reduce the contact area.

55. Which of the following method is applied to reduce barreling during upsetting or flat die forging?
(a) use of anisotropic materials as the work piece.
(b) use of very ductile materials such as aluminium and magnesium alloy.
(c) application of lubrication to reduce friction.
(d) application of elevated temperature during deformation.

56. What is the purpose of dummy block in hot extrusion process?
(a) to decrease coefficient of friction between billet and the container
(b) to avoid internal cracking or center-brust inside the product.
(c) to avoid formation of oxide film on the product.

(d) to decrease the extrusion ratio.

57. Which of the following is not the purpose of flux coating provided on the electrode in arc welding?
    a. To shield the molten pool from atmospheric gases
    b. To form slag which floats on the puddle and protects it from surrounding air during solidification
    c. To introduces special alloying elements to improve strength of weld metal
    d. Both a and b

58. What is the total amount of heat generated in a resistance spot welding cycle for duration of 0.15 second? The Welding current is 6000 A, and assume that the resistance is 75 micro-Ω.
a. 575 J
b. 405 J
c. 405kJ
d. 575kJ

59. Blanks of 50mm diameter are to be punched out of 2mm thick steel sheet. The edge (radial) clearance between punch and die is 5% of the sheet thickness. Determine the punch force if cutting resistance of the material is equal to 300 N/mm^2.
a. 20000.8 N
b. 34970.6 N
c. 3856.4 N
d. 94247.8 N

60. In which of the following welding process the heat is generated by chemical reaction.
a. Resistance welding
b. Thermit welding
c. Forge welding
d. Friction welding

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Answers Key PGAT (mech.)

1. B	21. C	
		41. B
2. A	22. B	42. B
3. C	23. A	43. B
4. D	24. D	44. A
5. A	25. B	45. D
6. D	26. B	46. C
7. B	27. D	47. D
8. C	28. A	48. B
9. A	29. C	49. A
10. C	30. A	50. A
11. C	31. A	51. C
12. D	32. B	52. B
13. A	33. A	53. A
14. C	34. B	54. B
15. B	35. C	55. C
16. A	36. C	56. C
17. D	37. C	57. C
18. C	38. B	58. B
19. B	39. B	59. D
20. A	40. A	60. B