भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

December 2018 Admissions to M.Tech/Ph.D Program

Department of Mechanical and Aerospace Engineering

Indian Institute of Technology Hyderabad

December 5th, 2018 - 10:30 am to 12:30 pm (2 hour)

Personal Information

1. **Name of the Candidate** :
2. **Application ID** :
3. **Email Id** :
4. **Mobile number** :
5. **Course Applied for** : M.Tech (3 Year) / PhD (Only External/Sponsored)
6. **Funding Category** : Institute Funded/ Externally Funded / Sponsored
7. **Choice of Stream for M.Tech Program** Select Options in Each Choice and Scratch Others

   TFE = Thermo-Fluid Engineering — 1st Choice = TFE / MAD / IDM

   MAD = Mechanics & Design — 2nd Choice = TFE / MAD / IDM

   IDM = Integrated Design & Manufacturing — 3rd Choice = TFE / MAD / IDM

8. **Educational Background (10th Class (or equivalent) level and above)**

Certificate / Degree	Specialization / Branch	Institute /College and Affiliated University	Completion Year	%, CGPA

Was the Bachelor's degree obtained through correspondence course / in distance education mode? Yes / No

Signature of the Applicant

Marks Obtained:

Correct Answers	Incorrect Answers	Not Attempted	Total Marks Obtained

Correct	Incorrect	Unattempt

1. Select the best suitable option (a, b, c, or d) and mark in the box in front of the question.
2. Each question carries one mark. <u>Negative marking</u> would be used and 0.5 marks would be deducted for wrong answer.

1. What is the value of $(1-i)^6$
   (a) $\sqrt{2}\,i$ (b) $-\frac{\pi}{4}i$
   (c) $4i$ (d) $8i$

2. Functions arccos(x) and cos(x) intersects in the range of
   (a) 0- π/6 (b) π/6-π/4
   (c) π/4-π/3 (d) π/3-π/2

3. If u(t) is unit function, r(t) is ramp function $\delta(t)$ is Direc delta function, find $\int_0^t \delta(\tau)\,d\tau$
   (a) u(t) (b) r(t)
   (c) u(t).r(t) (d) u(t)/r(t)

4. Evaluate $\int_{-\infty}^{\infty} \delta(t-t_0)\,e^{-i2\pi ft}dt$
   (a) $e^{-i2\pi ft}$ (b) $t_0 e^{-i2\pi ft_0}$
   (c) $t_0 e^{-i2\pi ft}$ (d) $e^{-i2\pi ft_0}$

5. Laplace transform of $5t^3$ is
   (a) $\frac{5}{s^4}$ (b) $\frac{1}{s^4}$
   (c) $\frac{30}{s^4}$ (d) $\frac{6}{s^4}$

6. Find the solution (x,y) of equations $(1/5)^x = 5^x = (1/2)^x = 2^x$
   (a) (0,0) (b) (1,0)
   (c) (0,1) (d) (1,1)

7. Differentiation of 5^x is
   (a) $5e^x$ (b) $\log(5^x)$
   (c) $5^x \log(5)$ (d) $x5^x \log(5)$

8. Evaluate $\int_0^1 \frac{1}{x-1}dx$?
   (a) Undefined (b) 0
   (c) ∞ (d) -∞

9. A differential equation $\left(\frac{d^3y(x)}{dx^3}\right)^2 + \left(\frac{d^2y(x)}{dx^2}\right)^3 + y(x) = x^3$ has order of
   (a) 6 (b) 3
   (c) 2 (d) 1

10. General solution of a differential equation $\frac{d^2y(x)}{dx^2} + y(x) = 0$ can be
   (a) $C\ \sin Ax \cos Ax$ (b) $C\ \cos(Ax-\theta)$
   (c) $A\,e^x + Be^{-x}$ (d) All of them

Correct	Incorrect	Unattempt

11 A tank was fitted with three pipes P, Q and R. P and Q are filling pipes and R is an emptying pipe. P and Q can fill the tank in 8 hours and 9 hours respectively. R can empty the tank in 18 hours. P, Q and R are opened at 5 a.m., 6 a.m. and 7 a.m. respectively. At what time will the tank be full?

(a) 9:00 am (b) 9:30 am
(c) 8:30 am (d) 10:00 am

12. In a certain room there are 4 boys, 4 girls and 8 chairs. In how many ways can the boys and girls be seated such that each of them is seated in a different chair and boys and girls sit alternately?

(a) 1440 (b) 1152
(c) 576 (d) 432

13. In the following series, two wrong numbers are given out of which one differs by a margin of 1 i.e., +1 or -1 and the other with a greater margin. From the choices, choose the number that is differing by the greater margin. The first number and the last number in the series are always correct.

5, 10, 25, 50, 120, 170, 290

(a) 10 (b) 25
(c) 50 (d) 120

14. A four digit number not less than 4000 and less than 7000 has the following features

(i) It is a multiple of 5
(ii) Both its two middle digits are between 4 and 7, both inclusive

How many possible values can the number take?

(a) 10 (b) 25
(c) 50 (d) 120

15. The units digit of $51^{51} \times 52^{52} \times 53^{53} \times 54^{54}$ is

(a) 8 (b) 6
(c) 4 (d) 2

16. The price of sugar decreases by 20%, by what percent must the consumption of sugar increase in order to have the expenditure on sugar increase by 5%?

(a) 12.5 % (b) 31.25 %
(c) 22.22 % (d) 16.66 %

17. In a rhombus ABCD, the diagonals meet at (5, 7). If the equation of the side AB is 3X + 4Y + 9 = 0, then equation of CD is

(a) 3X + 4Y + 14 = 0 (b) 3X + 4Y + 19 = 0
(c) 3X + 4Y - 95 = 0 (d) 3X + 4Y + 113 = 0

18. SCD, TEF, UGH, ____, WKL

(a) CMN (b) UJI
(c) VIJ (d) IJT

Correct	Incorrect	Unattempt

19. How many triplets of prime numbers can be formed such that the terms of the triplet are in arithmetic progression?

(a) 1 (b) 2

(c) 3 (d) More than 3

20. In the first 10 overs of a cricket game, the run rate was only 3.2. What should be the run rate in the remaining 40 overs to reach the target of 282 runs?

(a) 6.25 (b) 6.5

(c) 6.75 (d) 7

21 For the problem shown in Fig.1 what is the magnitude of frictional force at the interface between the mass and the inclined wall.

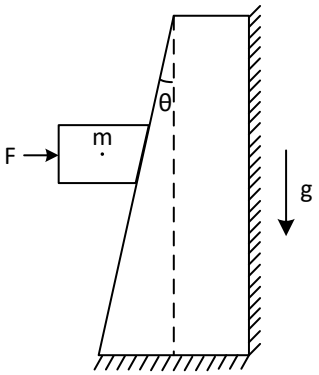


Fig. 1

Assume $F = m = g = 1, \mu = \frac{1}{2}, \theta = \frac{\pi}{4}$

(a) $\sqrt{2}$ (b) $\sqrt{2}^{-1}$

(c) 1 (d) 2

22 During the operation of the slider crank mechanism shown in Fig 2, the pin of the crank completely breaks releasing the crank. How many degrees of freedom does this system have after the pin breaks?

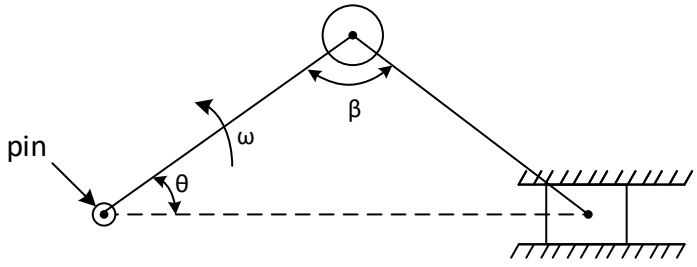


Fig. 2

(a) 1 (b) 2

(c) 3 (d) 4

Correct	Incorrect	Unattempt

23. A taut string under tension T is shown in Fig.3. What is the deflection of the string? Assume $T = L = F = 1$ and $a = 0.2$. Further assume small deformations.

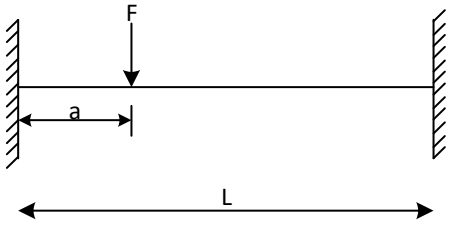


Fig. 3

(a) 0.2
(b) 1
(c) 0.1
(d) 0.16

24. For the system shown in Fig.4. calculate the natural frequency (cycles/sec). Assume $l_1 = l_2 = m_1 = m_2 = 1,\ k_t = 4, k = 5,$ and a=0.2.

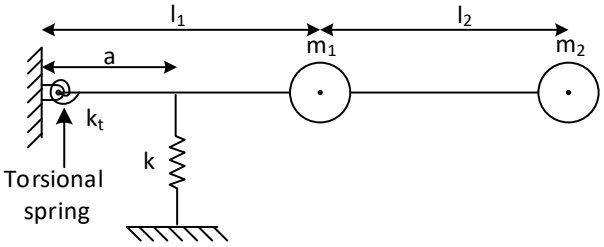


Fig. 4

(a) $\frac{1}{2\pi}$
(b) π
(c) $\frac{1}{\pi}$
(d) π^2

25. The ship shown in Fig.5 needs to be held steady in the water using a rope and a pole anchored to the ground. The ship exerts a tension of $T_1 = 12392$ on the rope. If the tension T_2 on the other side of the rope needs to be 1 .i.e., ($T_2 = 1$), how many times the rope should be rotated around the pole? Assume the coefficient of friction between the rope and the pole to be $\mu = 0.5$.

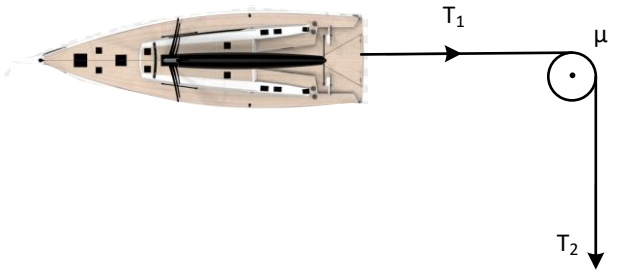


Fig. 5 (Top View)

(a) 2
(b) 1
(c) 3
(d) 4

Correct	Incorrect	Unattempt

26. Select the correct equations of motion for the system shown in Fig. 6

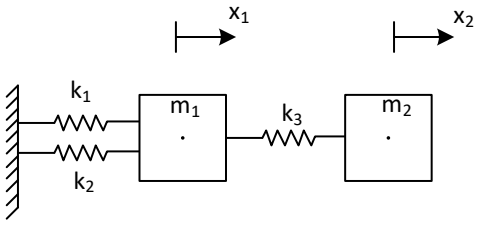


Fig. 6

(a) $m_1\ddot{x}_1 + (k_1 + k_2)x_1 + k_3(x_1 - x_2) = 0,\ m_2\ddot{x}_2 + k_3(x_2 - x_1) = 0$

(b) $m_1\ddot{x}_1 - (k_1 + k_2)x_1 + k_3(x_1 - x_2) = 0,\ m_2\ddot{x}_2 - k_3(x_2 - x_1) = 0$

(c) $m_1\ddot{x}_1 + (k_1 + k_2)x_1 - k_3(x_1 - x_2) = 0,\ m_2\ddot{x}_2 + k_3(x_2) = 0$

(d) $m_1\ddot{x}_1 + (k_1 + k_2)x_1 + k_3(x_2) = 0,\ m_2\ddot{x}_2 + k_3(x_1) = 0$

27. The boundary conditions for the free-free beam shown in Fig.7 are

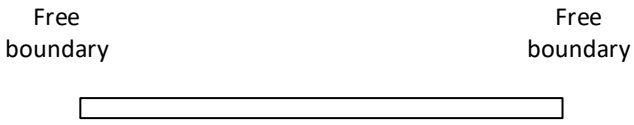


Fig. 7

(a) Slope and bending moment is zero at both ends

(b) Shear force and bending moment are zero at both ends

(c) Slope is not zero at both ends but bending moment is zero

(d) Slope is zero at both ends but bending moment is not zero

28. For the same dimensions and material properties, which boundary condition gives the maximum stiffness for the beam?

(a) Cantilever

(b) Fixed-pinned

(c) Pinned-pinned

(d) Fixed-fixed

29. Fig 9 shows a shaft of length L with area of cross section A welded at its base and subjected to a torque T at a distance of 'a' from its base, the bending stress at the root of the shaft is

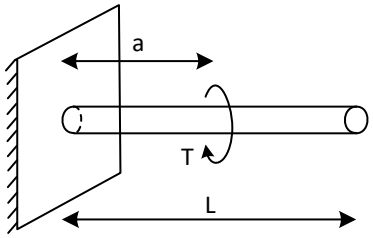


Fig. 9

(a) $\frac{T}{2aA}$

(b) $\frac{T}{aA}$

(c) $\frac{T}{LA}$

(d) 0

Correct	Incorrect	Unattempt

30. Consider a cantilever beam of length L, elastic modulus E and moment of inertia I. A force acts at the mid span. The deflection at this location is δ and rotation is α. What is the rotation of the free end?
    (a) 0 (b) α
    (c) 2α (d) $\frac{\alpha L}{2} + \delta$

31. In turning taper on half the length of a job 300 mm long, the tailstock was offset by 4 mm. What is the taper produced?
    (a) 1 in 300 (b) 1 in 37.5
    (c) 1 in 150 (d) 1 in 75

32. Half center is used during
    (a) Taper turning (b) Straight turning
    (c) Facing (d) Threading

33. The term 'kaizen' refers to
    (a) Feedback (b) Continuous Improvement
    (c) Small change (d) Product proving

34. Pitch line thickness of a gear can be measured by
    (a) Slip gauge (b) Gear tooth venire
    (c) Combination gauge (d) Pitch indicator

35. Which of the following is the softest
    (a) Austenite (b) Ferrite
    (c) Perlite (d) Bainite

36. CO_2 welding is an example of
    (a) MIG (b) TIG
    (c) MAG (d) PAW

37. Drop is caused by
    (a) High sulphur content (b) Very hard ramming
    (c) Too low pouring temperature (d) All of the above

38. DIN standard is mainly followed in
    (a) Germany (b) UK
    (c) USA (d) India

39. MPI and DPT are examples of
    (a) Chemical testing (b) Destructive testing
    (c) Non-destructive testing (d) None of the above

40. Carburizing, nitriding and Carbo-nitriding are examples of
    (a) Direct hardening (b) Diffusion hardening
    (c) Flame hardening (d) Selective hardening

Correct	Incorrect	Unattempt

41. Consider a 12.7 mm diameter sphere made of pure copper. It is at a uniform temperature of 66^0C when it is inserted into a stream of air at 27^0C. After 69 seconds, the temperature of the sphere drops to 55^0C. Assuming that the temperature of the sphere remains spatially uniform throughout the cooling process, calculate the heat transfer coefficient. Density of copper is $\rho = 8933$ kg/m^3; $C_p = 389$ J/kg K; thermal conductivity of copper k = 398 W/m K.

(a) h = 15 W/m^2 K (b) h = 55 W/m^2 K
(c) h = 35 W/m^2 K (d) h = 85 W/m^2 K

42. A thick walled stainless steel pipe has inner diameter of 20 mm and outer diameter of 40 mm. It is being electrically heated so as to provide a uniform heat generation rate of 10^6 W/m^3. The outer surface of the pipe is insulated. Water flows through the pipe at 0.1 kg/s. If the inlet temperature of water is 20^0C, what is the required pipe length if the desired outlet temperature of water is 40^0C? Thermal conductivity of stainless steel is 15 W/m.K; specific heat of water $C_p = 4.18$ kJ/kg.K; thermal conductivity of water is 0.617 W/m.K; viscosity of water is 803×10^{-6} N-s/m^2; Prandtl number of water is 5.45.

(a) 3.8 m (b) 8.9 m
(c) 17.3 m (d) 24.7 m

43. An astronaut inside the International Space Station seeks to boil water for his cup of tea. He has placed a lidded iron beaker filled with 300 ml of water over a magnetic hot plate that is electrically heated and delivers 100 Watts of heat to the beaker. The air pressure inside the space station is 1 atm., but it is a zero gravity environment. When compared to an identical water boiling contraption placed at sea level on earth, which of the following is true:-

(a) Water in the space station will boil twice as quickly as that on earth.
(b) Water will fail to boil in the space station and the electric heater will burn out.
(c) Water in the space station will boil twice as slowly that on earth.
(d) Water in both the space station and on earth will boil at the same time.

44. Two spheres, each 1.3 m in diameter, weighs 5 kN and 13 kN respectively. They are connected by a short rope and placed in water. What is the tension (T) in the rope?

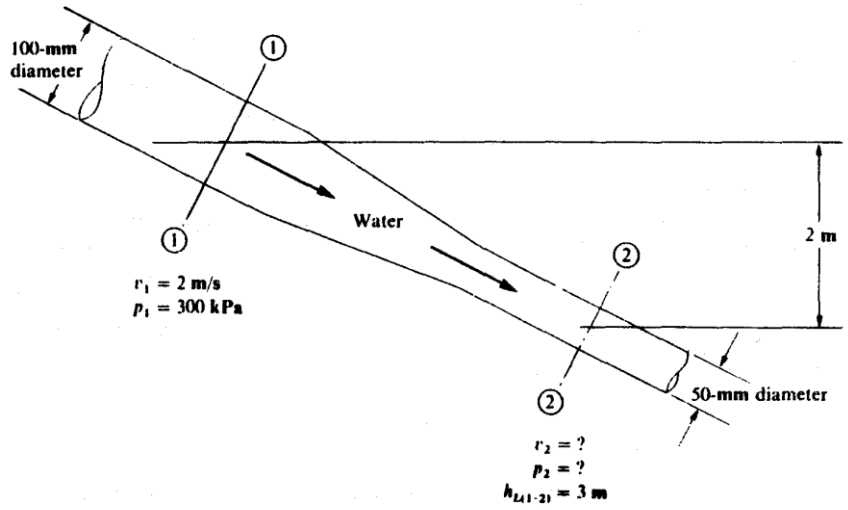
(a) 1.7 kN (b) 0 kN
(c) 3.9 kN (d) 0.4 kN

45. Which of the following velocity fields satisfy conservation of mass for incompressible planar flow?

(a) u = 3xt, v = 3yt (b)) u = xy + y^{2}t, v = xy + x^{4}t
(c) u = 4x^{2}y^3, v = -2xy^4 (d) u = 4x, y = 4y

Correct	Incorrect	Unattempt

46. Water flows from section 1 to section 2 of the pipe shown in the figure. Flow velocity at section 1 is 2 m/s and the pressure is 300 kPa. Total head loss from section 1 to section 2 is 3 m. Determine the water pressure at section 2.



(a) 690 kPa (b) 537 kPa
(c) 426 kPa (d) 260 kPa

47. A military aircraft with 8000 kg mass lands at 350 km/hr. The pilot deploys a braking parachute with 10 sq. metre area and a drag coefficient of 1.42. Estimate the time needed to slow the aircraft to 200 km/hr.

(a) 7 seconds (b) 5 seconds
(c) 11 seconds (d) 16 seconds

48. Consider a simple ideal Rankine cycle. If the condenser pressure is lowered while keeping turbine inlet state the same, which of the following will occur,

(a) the turbine work output will decrease.
(b) the amount of heat rejected will decrease.
(c) the cycle efficiency will decrease.
(d) the moisture content at turbine exit will decrease.

Correct	Incorrect	Unattempt

49. It is commonly recommended that hot foods be cooled first to room temperature by simply waiting a while before they are put into the refrigerator to save energy. Despite this common-sense recommendation, a person keeps cooking a large pan of stew three times a week and putting the pan into the refrigerator while it is still hot, thinking that the money saved is probably too little. But he says he can be convinced if you can show that the money saved is significant. The average mass of the pan and its contents is 5 kg. The average temperature of the kitchen is 23^0C, and the average temperature of the food is 95^0C when it is taken off the stove. The refrigerated space is maintained at 3^0C, and the average specific heat of the food and the pan can be taken to be 3.9 kJ/kg·^{0}C. If the refrigerator has a coefficient of performance of 1.5 and the cost of electricity is Rs. 10 per kWh, determine how much this person will approximately save a year by waiting for the food to cool to room temperature before putting it into the refrigerator.

(a) Rs. 40,000 (b) Rs. 40
(c) Rs. 4000 (d) Rs. 400

50. Which air standard cycle has the same four thermodynamic processes as the ideal Rankine cycle?

(a) Stirling cycle (b) Diesel cycle
(c) Brayton cycle (d) Otto cycle

FROM THIS POINT ONWARD SPACE IS PROVIDED FOR ROUGH WORK

Correct	Incorrect	Unattempt

Correct	Incorrect	Unattempt

Correct	Incorrect	Unattempt

Correct	Incorrect	Unattempt

Correct	Incorrect	Unattempt

Correct	Incorrect	Unattempt