University of Baghdad
College of Engr.
Mech. Engr. Dept.

Thermo-Fluids

Ph. D. Entrance Exam.

Time: 3 hr

Part I

Note : Answer " TEN " Questions Only

1. **Explain briefly FIVE of the following terms :**

a- Superheater b- Deaerator c- Governor d- Blowdown

e- Cavitation f- Air-ejector g- Waste heat boiler

2. **Write down the names of as many types of power generation cycles as you can. Briefly comment on each one as to efficiency, capacity, application, suitability, fuel …. etc.**

3. **Draw a single stage ideal Rankine cycle for power generation on a T-S diagram. Name and briefly explain each operation or process and the name of the equipment used in each process.**

4. **What are the types of turbines used in steam power plant generation systems. Describe the differences between them. Sketches may be used in your explanation.**

5. **Explain FIVE of the following terms :**

a- Air / Fuel ratio b- TDC c- Bore d- Crank angle

e- Octane number f- Carburator g- Clearance

6. **List as many combustion engine cycles as you can and briefly explain two of them. Use P-V diagrams to help in your explanations.**

7. **Write as many differences as you can between SI engines and CI engines. Sketches and equations may be used.**

8. **What is the difference between a supercharger and a turbocharger ? Discuss in detail. What is your opinion on adding a super- or turbo- charger to an SI engine.**

9. **Explain briefly FIVE of the following terms (equations and sketches may be used) :**

a- Internal energy b- Extensive variable c- Maxwell relation d- Entropy

e- Gibbs function f- Diathermal wall g- Thermodynamic potential

10. **Two processes of heating a certain mass between the same two temperatures T_1 & T_2 . The first process is at constant volume and the second process is at constant pressure. Draw the two processes on a T-S diagram and explain which will require more heat.**

11. **Show that the efficiency of a Carnot engine is the highest efficiency of any engine.**

12. **a- Temperature is _____**

b- The difference between a superheated vapor and a gas of the same substance is _____

c- An equation of state is _____

d- A reversible process is _____

Part II

Note : Answer " EIGHT " Questions Only

(1) What is the physical mechanism of heat conduction in (a- Solids b- Liquids c- Gases).

(2) A very high value of Prandtle number is a property of :

a- Air b- Water c- Oils d- Liquid metals

e- All the above f- None of the above

(3) Consider a hot boiled egg in a spacecraft that is filled with air at atmospheric pressure and temperature at all times. Will the egg cool faster or slower when the spacecraft is in space instead of on the ground ? Explain

(4) What is a blackbody ? How do real bodies differ from blackbody ?

(5) What are the most important differences between diffusion and radiation ? and how can the conduction and convection be defined in terms of them ?

(6) What is the criterion used for fully – developed temperature profile ? Support your answer with relations or equations.

(7) Derive the Reynolds analogy between heat and momentum transfer (St = Cf / 2), and discuss the drawbacks of this analogy.

(8) What is meant by the " Time Constant " of a thermocouple ? and how can we control its value ? Explain.

(9) The velocity and temperature profiles of liquid metal flow through a circular tube of radius (R), at each axial location is given by :

$u(r) = C_1$ and $T - T_w = C_2 [\ 1 - (r / R)^2\ ]$

where (C_1 and C_2) are constants and (T_w) is the wall temperature. Evaluate the Nusselt number of the flow.

(10) Write down the Cartesian form o f the energy equation of conduction heat transfer for heterogeneous anisotropic continua.

Part III

Q1: Encircle the correct answer:-

1- A flow in which the quantity of liquid flowing per second is not constant, is called:
a- stream line flow b- turbulent flow c- steady flow d- uniform flow e- none of these

2- A differential manometer is used to measure:
a- velocity of the liquid b- atmospheric pressure c- pressure in the pipes and channels
d- pressure in venturimeter e- none of these

3- Euler equation is based on the assumption that:
a- the fluid is non-viscous b- the fluid is homogenous and incompressible
c- steady and along the stream line d- the velocity of flow is uniform e- none of the above

4- Reynolds number is the ratio of the inertia force to the:
a- surface tension force b- viscous force c- gravity force d- elastic force e- none of these

5- The stagnation pressure, in an isentropic pipe flow is:
a- remain constant through the pipe b- increases in pipe downstream
c- decreases in pipe downstream
d- decreases in pipe downstream and increases in pipe upstream e- none of these

6- Flow through a normal shock:
a- stagnation temperature increases b- stagnation temperature decreases
c- stagnation temperature remains constant
d- stagnation temperature equals stagnation pressure e- none of these

7- The Mach number in supersonic flow, adiabatic and constant area duct with friction will:
a- increase through the duct towards unity b- decrease through the duct towards unity
c- be equal through the duct d- increase and decrease thought the duct e- none of these

8- The cavitation phenomena in a hydraulic machine:
a- causes noise and vibration of various parts b- makes the blade surface rough
c- Reduces the discharge of a turbine d- all of the above e- None of the above

9- Pumps in parallel are used :
a- to give high head b- to give high discharge c- to pump viscous fluids
d- all of the above e- none of the above

10- Net positive suction head for the pump depends on:
a- atmospheric pressure only b- atmospheric pressure and flow velocity only
c- flow velocity only
d- atmospheric pressure, flow velocity and vapor pressure of the fluid only e- none of these

11- The cavitation in a hydraulic machine:
a- causes noise and vibration of various parts b- makes blades surface rough
c- reduces the discharge of a turbine d- all of the above e- none of the above

12- For radial flow between parallel discs, the pressure gradient will balance the inertia terms if:
a- Re → 0 and causes repelling force between the discs
b- Re → ∞ and causes repelling force between the discs
c- Re → 0 and causes attraction force between the discs
d- Re → ∞ and causes attraction force between the discs
e- none of these

13- The reversed flow is obtained if:
a- the flow is under zero pressure gradient
b- the negative pressure acts over a sufficient length
c- the positive pressure acts over a sufficient length
d- the favorable pressure acts over a sufficient length

e- none of these

14- In potential flow around a body, the drag is:

a- always positive b- always negative c- always balance the body force

d- always balance the pressure force e- always zero

15- In analysis of boundary layer flow, the pressure across the boundary layer:

a- Is zero b- Is positive c- Is negative d- Greater than unity e- None of these

…… (60 points)

Q2: For a flow over the flat plate, discuss the effects of the positive pressure gradient on length of laminar portion of the boundary layer, boundary layer thickness and shear stress at the wall.

……..…….…. (10 points)

Q3: Use an elemental approach to show that, in pipe flow, the shear stress varies linearly from zero value at the centerline to maximum value at the surface of the pipe. State all assumptions.

…….…….... (30 points)

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Ph. D. Entrance Exam.

Applied Mechanics
Time: 3 hr

Part A: Control & Vibrations (34 M)

Choose the correct answers to multiple choice questions:

1- The roots of the quadratic equation : $S^2 + 3S + 5 = 0$ are :

a) $S_{1,2} = -3 \pm j\sqrt{11}$ **b)** $s_{1,2} = -1.5 \pm j\sqrt{11/2}$

b) c) $S_{1,2} = -5 \pm j\sqrt{13/2}$ **d))** $S_{1,2} = -2.5 \pm j\sqrt{13/2}$

2- For the following diagram , which statement is correct :

a) z(t) = a(t) + b(t) – c(t) + d(t)
b) z(t) = a(t) + b(t) +c(t) + d(t)
c) z(t) = - (a(t) + c(t)) +(b(t) + d(t))
d) z(t) = -a(t) - b(t) -c(t) + d(t)

3- What are the time constants of the following transfer function $G_1(s) = \frac{2}{0.5S+1}$, $G_2(s) = \frac{6}{3S+2}$

a) 0.5 , 1.5 b) 0.5 , 3 c) 4 , 2 d) 0.5 ,2

4- $G_1(s), G_2(s)$ *and* $G_3(S)$ **have the same gain , but time constants of 3,4 and 5 seconds respectively . which responds more quickly to a step input ?**

a) They all respond the same since the gain is the same . b) G1(S) c) G2(S) d) G3(S)

5- What are the gain and natural frequency of the following system transfer function

$G(S) = \frac{36}{S^2+3S+36}$ **? a) 36,6 b) 6,6 c) 1,6 d) 6,1**

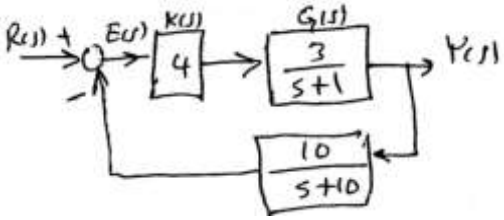
6- The forward feedback and closed loop transfer function for the system are:

a) $\frac{3}{2s+1}$ **,0 ,** $\frac{30}{2s+31}$ **b)** $\frac{30}{2s+1}$ **,1 ,** $\frac{30}{2s+30}$

c) $\frac{30}{2s+1}$ **,1 ,** $\frac{30}{2s+31}$ *d)* $\frac{30}{2s+1}$ **,0 ,** $\frac{30}{2s+31}$

7- What is the characteristic equation of this system?

a) $S^2 + 11S + 10$
b) $S^2 + 11S + 130$
c) $S^2 + 10S + 120$
d) $S^2 + 10S + 12$



8- IF $E(S) = \frac{6}{S^2+3S+4} R(S)$ *what is* e_{ss} **if the input signal is a step input of magnitude 2 ?**

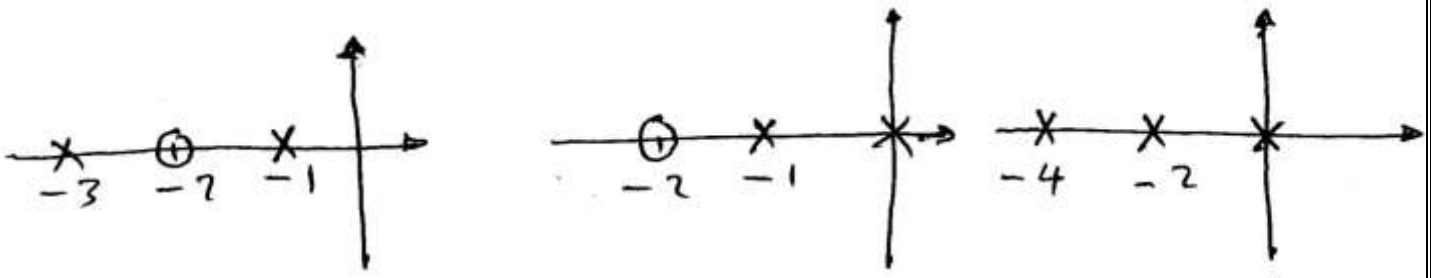
a) 3 b) 6 c) 1.5 d) 2

9- The percentage overshoot of a second order system to a step input depends only on :
a) the value of the step input b) the value of the damping ratio c) the value of the gain k
d) the parameter ω_n

10 What are the pole p , and zero , z , of the transfer function $G(S) = \frac{S+2}{S+3}$?

a) P=2 , z=3 b) p=3 , z=2 c) p=-2 , z=-3 d) p=-3 , z=-2

11 Draw the root- locus plot and write the characteristic equations for the following systems



12 What are the advantages of Rouths stability criterion .

13 Draw the specification of transient response showing the $t_r , t_s , t_p , p.o.s$ and e_{ss}

14 Explain by drawing and write the formula for the gain margin and phase margin for type one system third order differential equation.

15 What are the types of frequency, write the formula for each type with units.

16 Consider a single degree of freedom system with mass , spring and viscous damping excited by a harmonic force . draw the curves between the amplitude and the phase angle against frequency ratio $\frac{\omega}{\omega_n}$ where is the effect of damping ratio on the amplitude and phase ?

17 What are the facts of the rigid – body mode?

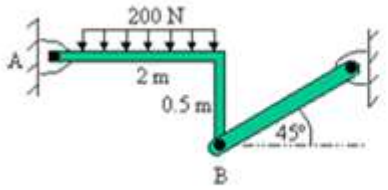
18 Explain by drawing all types of the frequency response representation.

19 What are the methods for solving the non – linear vibration system?

20 What are the methods for finding the fundamental frequency (approximate), write these formula?

Part B: Design , Statics & Strength of Materials (34 M)

1. Draw the free-body diagram of member AB then list the number of unknowns.



Number of unknowns = ?

One answer only.

- ○ 2
- ○ 3
- ○ 4
- ○ None of the above

2. Describe the procedure for finding out the stresses in a composite bar.

3. Distinguish clearly between direct stress and bending stress.

4. Write a note on the influence of various factors of the endurance limit of a ductile material.

5. When the shaft is subjected to fluctuating loads, what will be the equivalent twisting moment and equivalent bending moment ?

6. How does the function of a brake differ from that of a clutch ?

7. How do you express the life of a bearing? What is an average or median life?

8. Explain the different causes of gear tooth failures and suggest possible remedies to avoid such failures.

Choose the Correct Answer :

9. If the sum of all the forces acting on a moving object is zero, the object will:

- ○ 1. slow down and stop
- ○ 2. change the direction of its motion
- ○ 3. accelerate uniformly
- ○ 4. continue moving with constant velocity

10. Maximum shear stress theory (also known as Guest's or Tresca's theory is mostly used for designing members of:
(a) Ductile material (b) Brittle material (c) Composite material (d) Non of the above

11. The ratio of linear stress to linear strain is called:
(a) Modulus of elasticity (b) Modulus of rigidity (c) Bulk modulus (d) Poisson's ratio

12. The modulus of elasticity for mild steel is approximately equal to:
(a) 80 kN/mm^2 (b) 100 kN/mm^2 (c) 110 kN/mm^2 (d) 210 kN/mm^2

13. An aluminum member is designed based on:
(a) yield stress (b) elastic limit stress (c) proof stress (d) ultimate stress

14. In a body, a thermal stress is one which arises because of the existence of:
(a) Latent heat (b) Temperature gradient (c) Total heat (d) Specific heat

15. The stress in the bar when load is applied suddenly is ..... as compared to the stress induced due to gradually applied load.
(a) same (b) double (c) three times (d) four times

16. Two shafts under pure torsion are of identical length and identical weight and are made of same material. The shaft A is solid and the shaft B is hollow. We can say that:
(a) shaft B is better than shaft A (b) shaft A is better than shaft B
(c) both the shafts are equally good

17.The maximum shear stress developed in a beam of rectangular section is ..... the average shear stress.
(a) equal to (b) 3/4 times (c) 1.5 times

18. In case of pressure vessels having open ends, the fluid pressure induces:
(a) Longitudinal stress (b) circumferential stress (c) Shear stress (d) none of these

19. The endurance or fatigue limit is defined as the maximum value of the stress which a polished standard specimen can withstand without failure, for infinite number of cycles, when subjected to
(a) static load (b) dynamic load (c) static as well as dynamic load (d) completely reversed load

20. Stress concentration factor is defined as the ratio of:
(*a*) maximum stress to the endurance limit (*b*) nominal stress to the endurance limit
(*c*) maximum stress to the nominal stress (*d*) nominal stress to the maximum stress

21. In cyclic loading, stress concentration is more serious in:
(a) brittle materials (b) ductile materials (c) brittle as well as ductile materials
(d) elastic materials

22. The strength of the un-riveted or solid plate per pitch length is equal to:
(a) $p \times d \times \sigma_t$ (b) $p \times t \times \sigma_t$ (c) $(p - t)\, d \times \sigma_t$ (d) $(p - d)\, t \times \sigma_t$

23. In transverse fillet welded joint, the size of weld is equal to:
(a) 0.5 × Throat of weld (b) Throat of weld (c) $\sqrt{2}$ × Throat of weld (d) 2 × Throat of weld

24. When a nut is tightened by placing a washer below it, the bolt will be subjected to:
(a) tensile stress (b) compressive stress (c) shear stress (d) none of these

25. In a steam engine, the piston rod is usually connected to the crosshead by means of a:
(a) knuckle joint (b) universal joint (c) flange coupling (d) cotter joint

26. A keyway lowers:
(a) the strength of the shaft (b) the rigidity of the shaft
(c) both the strength and rigidity of the shaft (d) the ductility of the material of the shaft

27.Which of the following loading is considered for the design of axles ?
(a) Bending moment only (b) Twisting moment only (c) Combined bending moment and torsion
(d) Combined action of bending moment, twisting moment and axial thrust

28. The power transmitted by means of a belt depends upon:

(a) velocity of the belt (b) tension under which the belt is placed on the pulleys
(c) arc of contact between the belt and the smaller pulley (d) all of the above

29. Which one of the following is a positive drive?
(a) Crossed flat belt drive (b) Rope drive (c) V-belt drive (d) Chain drive

30. When a helical compression spring is subjected to an axial compressive load, the stress induced in the wire is:
(a) tensile stress (b) compressive stress (c) shear stress (d) bending stress

31. sliding bearing which can support steady loads without any relative motion between the journal and the bearing is called:
(a) zero film bearing (b) boundary lubricated bearing
(c) hydrodynamic lubricated bearing (d) hydrostatic lubricated bearing

32. The static tooth load should be ..... the dynamic load.
(a) less than (b) greater than (c) equal to

33. The size of gear is usually specified by:
(a) pressure angle (b) pitch circle diameter (c) circular pitch (d) diametral pitch

Part C: Dynamics , Theory of Machines , Elasticity & Plasticity (34 M)

Q1) Fill in the blank with suitable descriptions or solved equations :

1- If the moment of inertia of a body about an axis through its centre of gravity is known , then the moment of inertia about any other parallel axis is ----------

2- For angular motion, the work done is ---------- and the angular momentum is ----------

3- For polar coordinates, the Airy stress function Φ can be modified to get σr = ----------
σΘ = ----------

and τrθ = ----------

4- The material in complex stress analysis could be failed if the yield stress of the material σyield = ----------or σyield = ----------

5- The relation between true stress and engineering stress is ----------
while between true strain and engineering strain is ----------

Q2) Detect the sentences if it is *FALSE* or *TRUE* and correct the false ones :-

1- The collision of two bodies of masses m1 , m2 and initial velocities u1 , u2 and final velocities v1 , v2 in opposite directions is $m1 \times u1 - m2 \times u2 = m1 \times v1 + m2 \times v2$

2- The frictional torque of plate clutch can be derived as $\frac{T1}{T2} = e^{\mu\theta}$

3- In pressure vessel of diameter (d) and thickness (t) is the max principle stress σ1 = σ2

4- The deviatoric stress in three dimensional stress analysis is $\frac{\sigma 1+\sigma 2+\sigma 3}{3}$

5- The relation between plastic stress and plastic strain in the plastic deformation of a body is $\in = \frac{\sigma 1}{E}(\sigma 2 + \sigma 3(1 - v))$

Q3) ANSWER with equations only :-

1- What is the conservation of momentum for two bodies have mass moment of inertia I1,I2 , and rotate in common angular velocity w ?

2- What are the acceleration components of the sliding link in four bar mechanism ?

3- What is the value of the plastic stress for a material linear elastic linear work hardening ?

4- What is the collapse load for a simply supported beam of length l with mid plane load p ?

5- What are the portal frame ? and how could we find the modes of failure ?

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M. Sc. Entrance Exam.

Thermo-Fluids
Time: 3 hrs.

Answer the Following Questions

(1) A mercury barometer reads (75.8 cm). Express the reading in Pascals (S_{Hg} =13.6).

(2) The velocity of water through a (4 cm) diameter pipe is (3 m/s). Calculate the discharge and mass flow rate.

(3) A jet of water (1 cm) in diameter and velocity of (10 m/s) impinges normally on a stationary vertical flat plate. The force excerted by the jet on the plate is :

a-78kgf drag b- 78 N lift c- 7.8 N drag d- 7.8 N lift

(4) The friction factor in a (2.5 cm) diameter pipe is (0.02). The pipe length is (10 m) and the velocity is (4 m/s) of water. Calculate the pressure drop over the pipe.

(5) In supersonic isentropic flow of a perfect gas, an increase in area causes:

a-Increase in velocity b-Increase in pressure c-Decrease in velocity d-Increase in density

(6) A normal shock wave in supersonic flow causes :

a-Increase in Mach number b-Decrease in stagnation pressure c-Decrease in stagnation temperature d-None of the above

(7) A subsonic nozzle is a :

a-Converging passage b-Diverging passage c-Converging-diverging passage

(8) A Pelton wheel is an : a-Axial flow impulse turbine b-Inward flow impulse turbine c-Outward flow impulse turbine d-Inward flow reaction turbine e-Outward flow reaction turbine

(9) A Francis turbine is an outward flow reaction turbine: a- True b-False

(10) A Kaplan turbine is an axial flow reaction turbine: a-True b-False

(11) A draft tube is used with Impulse turbine: a-True b-False

(12) The performance of air compressor at high altitude will be _____ as compared to that at sea level: a-Same b-Lower c-Higher

(13) What are the basic modes of heat transfer ? and what are the basic laws which are used to calculate the heat transfer rate in each mode ?

(14) A very low value of Prandtle number is a property of _____ :

a- Air b- Water c- Oils d- Liquid Metals e- All the above f- None of the above

(15) A very high value of heat transfer coefficient is found in :

a- Natural convection b- Boiling c- Forced Convection d- All the above

(16) What are the most important dimensionless numbers in each of the following phenomena :

a- Natural convection heat transfer in incompressible fluids

b- Forced convection heat transfer in incompressible fluids

c- Unsteady conduction heat transfer

(17) Estimate the Carnot efficiency of an engine working between (2000 K) and (20 ^{o}C) temperature reservoirs.

(18) A system undergoes a process in which heat of the amount (100 kJ) is transferred to it and the work done by the system is (6500 N.m). Estimate the change in internal energy of the system.

(19) Throttling process is; a- Adiabatic b- Isothermal c- Isentropic d- Isobaric

(20) A difference in Fahrenheit of (180 ^{o}F) is equivalent to a difference of ;

a- 100 ^{o}C b- 82.2 ^{o}C c- 38.1 ^{o}C d- 68.6 ^{o}C

(21) What are the basic differences between spark ignition and Diesel engines ? Briefly explain using sketches or diagrams if necessary.

(22) In air-conditioning cooling load calculations, there are internal and external sources of heat. Name as many as you can and indicate whether the load is sensible, latent or both.

(23) Reheat in a gas turbine;

a- Increases thermal efficiency b- Increases compressor work

c- Increases turbine work d- Decreases thermal efficiency

(24) What are the most important desirable properties of a refrigerant ?

(25) What is the state (condition) of the refrigerant in a vapor-compression cycle at the following points in the cycle ;

a- Before entering the compressor b- After leaving the compressor

c- Before entering the condenser d- After leaving the condenser

e- Before entering the evaporator d- After leaving the evaporator

(26) The intake valve of a four-stroke ICE remains open for ;

a- 130 ^{o} b-180 ^{o} c- 230 ^{o} d- 270 ^{o}

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M. Sc. Entrance Exam.

Applied Mechanics
Time: 3 hrs.

Part A: Statics & Strength of Materials (30 M)

1. Complete the following statements:
A body is in translational equilibrium
(choose the correct answer) ⟶

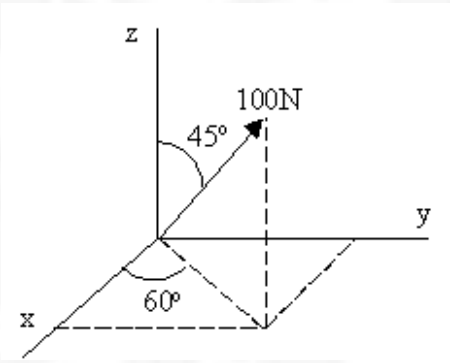
a. Only if it is at rest
b. Only if it is moving with constant velocity
c. Only if it is moving with constant velocity
d. If it is either at rest or moving with constant velocity
e. If it is moving with either constant velocity or constant acceleration

2. Two uniform solid spheres, A and B have the same mass. The radius of sphere B is twice that of sphere A. The axis of rotation passes through each sphere. Which one of the following statements concerning the moments of inertia of these spheres is true?
(choose the correct answer) ⟶

a. The moment of inertia of A is one-fourth that of B
b. The moment of inertia of A is one-half that of B
c. The moment of inertia of A is 5/4 that of B
d. The moment of inertia of A is 5/8 that of B
e. The two spheres have equal moments of inertia

3. Select the answer that gives the y-component for the 100-N force, F_y= ?
One answer only.

a) **100sin45sin60**
b) **100sin45cos60**
c) **100cos45cos60**
d) **100cos45/sin60**
e) **None of the above**

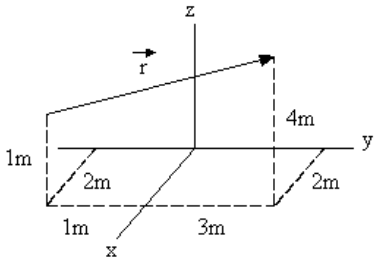


4. Calculate the magnitude of the force.
F = (30i - 40j) N.
F = ?
One answer only ⟶

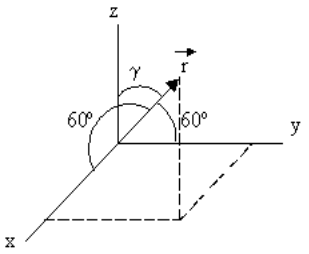
a) 25 N
b) 40 N
c) 50 N
d) None of the above

5. Select the answer that represents the position vector r. r = ? *One answer only.*

a) (-2i - 4j + 3k) m
b) (3i + 4j) m
c) (4j + 3k) m
d) (2i + 4j + 4k) m
e) None of the above



6. If r has a magnitude of 10m, calculate .



γ = ?

One answer only.

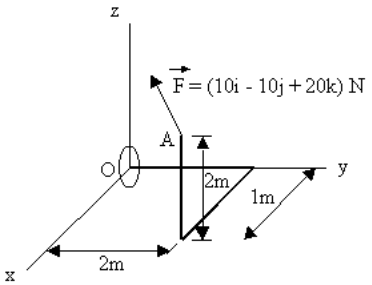
a) -45
b) 25
c) 45
d) 60
e) None of the above

7. Calculate the moment of the force about point O using the vector cross product and select the correct answer.

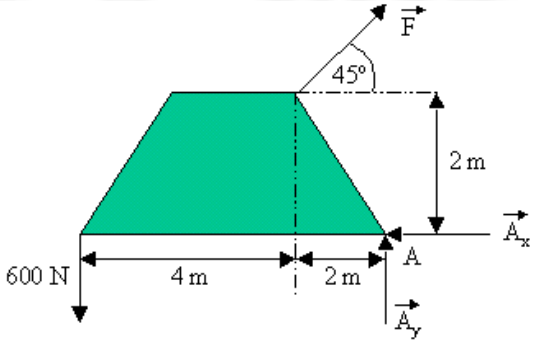
M_O= ?

One answer only

a) (20i - 30k) Nm
b) (60i - 30k) Nm
c) (60i - 30j) Nm
d) (60i + 40j - 30k) Nm
e) None of the above



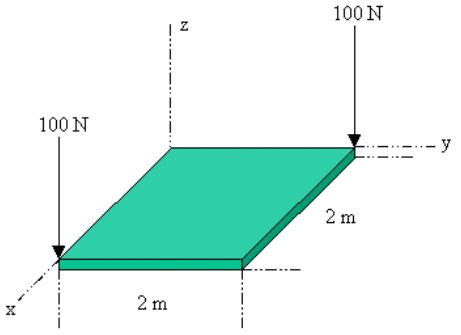
8. The free-body diagram is shown in the figure. Select the equation that represents the moment equilibrium equation about point A. Assume positive moments are clockwise.



One answer only.

a) Fcos45(2m) + Fsin45(2m) - 600N(6m) = 0
b) Fcos45(2m) - Fsin45(2m) - 600N(6m) = 0
c) -600N(6m) - Fcos45(2m) - Fsin45(2m) = 0
d) None of the above

9. Calculate the equivalent single resultant force and specify its x and y coordinates.

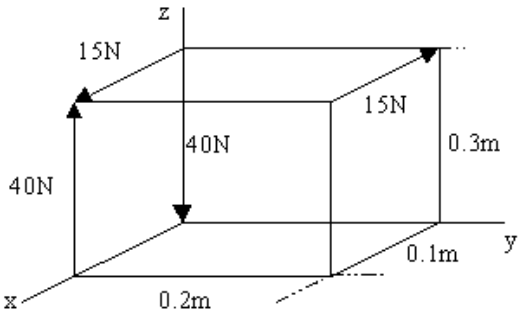


F_{rz}= ?

One answer only

a) 0
b) 100 N (down)
c) 200 N (down)
d) 400 N (down)
e) None of the above .

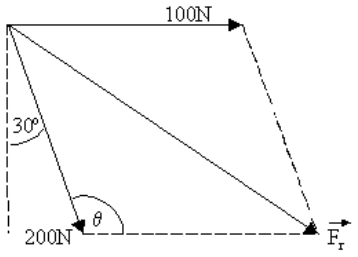
10. Select the answer that represents the magnitude of the resultant couple moment acting on the block.



One answer only

a) 5 Nm
b) 3 Nm
c) 4 Nm
d) 7 Nm
e) None of the above

11. Two forces are to be added to determine the resultant force F_r. Compute the angle q = ?

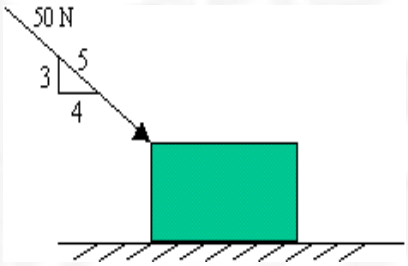


One answer only

a) 120
b) 140
c) 160
d) None of the above

12. On a sheet of paper draw the free-body diagram of the block which has a weight of 100 N. Then calculate the frictional force acting at the surface of contact.

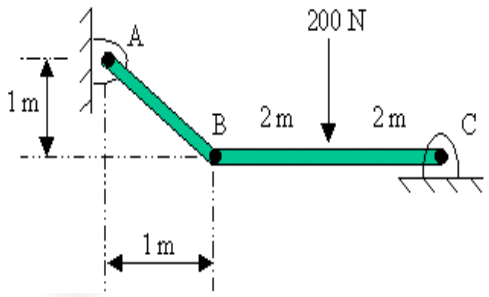
$\mu_s = 0.2, \mu_k = 0.2$ F = ?



One answer only

a) 13 N
b) 20 N
c) 26 N
d) 40 N

13. On a sheet of paper draw the free-body diagram of member BC, then specify the single equation of equilibrium that should be applied to determine the resultant force acting at the ends of the two-force member AB.



One answer only.

a) $\sum M_C = 0$
b) $\sum M_B = 0$
c) $\sum F_x = 0$
d) None of the above

14. Which one of the following statements concerning Hook's law is false?

(a) Hook's law relates stress and strain.
(b) Hook's law is valid only for springs.
(c) Hook's haw can be verified experimentally.
(d) Hook's law can be applied to a wide range of materials.
(e) Hook's law is valid only within the elastic limit of a given material.

15. The impact strength of a material is an index of its:
(choose the correct answer) ⟶

a) Toughness
b) Tensile strength
c) Capability of being cold worked
d) Hardness
e) Fatigue strength

16. If a material expands freely due to heating, it will develop:
(choose the correct answer) ⟶

(a) Thermal stress
(b) Tensile stress
(c) Bending
(d) Compressive stress
(e) No stress

17. The change in length due to tensile or compressive force acting on a body is given by:
(choose the correct answer) ⟶

(a) PlA/E
(b) Pl/AE
(c) E/PlA
(d) None of the above

18. Toughness of a material is equal to area under _____ part of the stress-strain curve.

(a) Elastic
(b) Plastic
(c) Both
(d) None

19. True stress-strain curve need to be corrected after:
(choose the correct answer) ⟶

(a) Elastic limit
(b) Yield limit
(c) Tensile strength
(d) no need to correct

20. Time dependent yield is known as:

(choose the correct answer) ⟶

(a) Fracture
(b) Fatigue
(c) Buckling
(d) Creep

Part B: Dynamics & Theory of Machines (30 M)

Q1) Fill in the blank with suitable descriptions or solved equations :-

1- The momentum of a body for translating motion is ----------

and for angular motion is ----------

2- The conservation of angular momentum is ----------

3- Two gears A and B having moment of inertia Ia and Ib respectively mesh with speed $\omega b/\omega a = n$ then the torque Ta required to be applied to wheel A to accelerate wheel B is:

4- In four bar mechanism the acceleration of the sliding links are divided into two components one is equal to ----------and the other is equal to

----

5- In the belt drive the tension in the slack side can be calculated by ---------- ---------- and the power transmitted from driver to the driven pulley is ----------

Q2) detect the sentences if it is false or true and correct the false ones:

1- The conservation of linear momentum is $\frac{1}{2}mv^2 + mgh = 0$.

2- The mass moment of inertia can be found from the area of the body only.

3- In turning moment diagram for multi – cylinder engine is the relation between turning moment and crank angle.

4- In reciprocating masses the unbalanced force is balanced by additional mass in the connecting rod .

5- The construction of cam profiles is drawn dependent on the forces that applied on the cam by the follower.

Q3) ANSWER with equations only :-

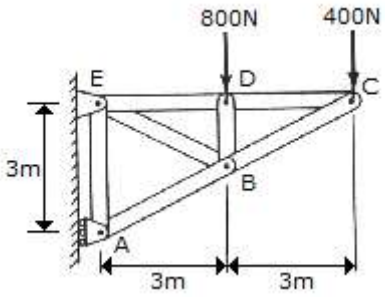
1- For constant angular acceleration what are the angular velocity of a body after time t ?

2- If mass (m) falls from high (h) what is its velocity (v) ?

3- What is the couple effect on a vehicle turning around a curve?

Part C: Design (15 M)

1. Determine the force in member CB of the truss and indicate whether the members are in tension or compression.



2. A 25 mm diameter bar is subjected to an axial load of 1000KN. Under the action of this load a 200 mm gauge length is found to extend 0.19 x 10^{-3} mm. Determine the modulus of elasticity for the bar material.

3. What useful information is obtained from the tensile test of a ductile material?

4. Write the relations used for maximum stress when a machine member is subjected to tensile or compressive stresses along with shearing stresses.

5. What is meant by endurance strength of a material? How do the size and surface condition of a component and type of load affect such strength?

6. Distinguish between circumferential stress and longitudinal stress in a cylindrical shell, when subjected to an internal pressure.

7. Discuss how the pipes are designed.

8. Show by neat sketches the various ways in which a riveted joint may fail.

9. What type of stresses are induced in shafts?

Choose the Correct Answer :

10. According to distortion-energy criterion, yielding occurs when:
(a) Distortion energy reaches a critical value
(b) Second invariant of the stress deviator exceeded some critical value
(c) Octahedral shear stress reaches a critical value
(d) All the above

11. The neutral axis of a beam is subjected to:
(a) zero stress **(b) maximum tensile stress**
(c) maximum compressive stress **(d) maximum shear stress**

12. If d = diameter of solid shaft and τ permissible stress in shear for the shaft material, then torsional strength of shaft is written as:

$(a)\ \frac{\pi}{32} d^4 \tau$, $(b)\ d \log_e \tau$, $(c)\ \frac{\pi}{16} d^3 \tau$, $(d)\ \frac{\pi}{32} d^3 \tau$

13.Failure of a material is called fatigue when it fails:
(a) at the elastic limit **(b) below the elastic limit**
(c) at the yield point **(d) below the yield point**

14.The parallel fillet welded joint is designed for:
(a) tensile strength **(b) compressive strength**
(c) bending strength **(d) shear strength**

15. A bolt of M 24 × 2 means that:
(a) the pitch of the thread is 24 mm and depth is 2 mm
(b) the cross-sectional area of the threads is 24 mm2
(c) the nominal diameter of bolt is 24 mm and the pitch is 2 mm
(d) the effective diameter of the bolt is 24 mm and there are two threads per cm

16. The design of shafts made of brittle materials is based on:
(a) Guest's theory **(b) Rankine's theory**
(c) St. Venant's theory **(d) Von Mises Theory**

17. In designing a connecting rod, it is considered like..... for buckling about X-axis.
(a) both ends hinged **(b) both ends fixed** **(c) one end fixed and the other end hinged**
(d) one end fixed and the other end free:

18. The backlash for spur gears depends upon:
(a) module **(b) pitch line velocity**
(c) tooth profile **(d) both (a) and (b)**

Part D: Vibrations (10 M)

Q1: **Fill in the blanks using the words between brackets at the end of each sentence :**

1: When the motion is repeated in equal intervals of time τ it is called _____. The time repletion time τ is called the _____ of oscilation , and its reciprocal $f = 1/\tau$ is called the _____. The simplest form of periodic motion is _____. The displacement in harmonic motion is often represented by _____.

(harmonic motion , $A sin\omega t$, frequency , periodic motion , period)

2: The circular frequency ω_n may be defined by _____, and the natural frequency $f_n$is _____. These quantities may be expressed in terms of the statical deflection Δ as _____.

($\frac{2\pi}{\tau}$, $\frac{1}{\tau}$, $f_n = \frac{1}{2\pi}\sqrt{\frac{g}{\Delta}}$, $f_n = 2\pi\sqrt{\frac{g}{\Delta}}$, $\sqrt{\frac{k}{m}}$, $\sqrt{\frac{g}{\Delta}}$)

3: In a viscously damped free vibration of a single degree of freedom spring-mass system , the displacement x may by be found to be $x = e^{-\left(\frac{c}{2m}\right)t}\left(A\, e^{\sqrt{(\frac{c}{2m})^2 - \frac{k}{m}}t} + B\, e^{-\sqrt{(\frac{c}{2m})^2 - \frac{k}{m}}t}\right)$, the first term is simply an _____ function of time . When the damping term $(c/2m)^2$ is _____ than $\frac{k}{m}$ the exponents in the above equation are _____ numbers and

_____ are possible. We refer to this case as _____ when the damping term $(c/2m)^2$ is _____ than $\frac{k}{m}$ the exponent becomes _____number; the terms of the above equation within the parentheses are _____. We refer to this case as _____. In the limiting case between the oscillatory and non oscillatory motion $(c/2m)^2 = \frac{k}{m}$, and the radical is zero. The damping corresponding to this case is called _____.

(under damped, oscillatory, critical damping, an imaginary, non oscillation, over damped, real , less , larger, exponentially decaying)

4: In a forced harmonic vibration of a single degree of freedom spring-mass system , when $\omega/\omega_n \ll 1$ both the inertia and damping forces are _____which result in a _____ phase angle φ. The magnitude of the impressed force is then nearly equal to the _____. For $\omega/\omega_n = 1$ the phase angle is _____ and the inertia force, which is now _____, is balanced by the _____where as the impressed force overcomes the _____. At large values of $\omega/\omega_n \gg 1$, φ approaches _____and the impressed force is expended almost entirely in overcoming the large _____.

(large,small, 90^o, 180^o, 360^o ,spring force, damping force, inertia force)

***Q2*: determine the natural frequency of the mass M on the end of a cantilever beam of a neglegibel mass shown in the figure. The deflection of the cantilever beam under a concentrated force P is $x = \frac{p\,L^3}{3EI}$**

***Q3*: the logarithmic decrement is defined as the natural logarithm of the ratio of any successive amplitudes. If the logarithmic decrement is 0.429:**

a) Determine the ratio of any two successive amplitudes.

b) Show that the logarithmic decrement is also given by the equation $\delta = \frac{1}{n} ln \frac{x_o}{x_n}$

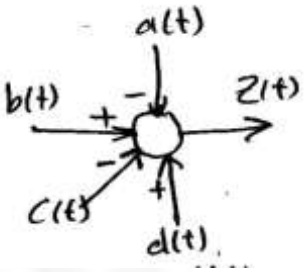
Part E: Control & Measurements (15 M)

Choose the correct answers to multiple choice questions:

Q1)The root of the quadratic equation : $s^2+3s+5=0$ **are:**

a) $s_{1,2}=-3\pm j\sqrt{11}$, **b)** $s_{1,2}=-1.5\pm j\frac{\sqrt{11}}{2}$, **c)** $s_{1,2}=-5\pm j\frac{\sqrt{13}}{2}$, **d)** $s_{1,2}=-2.5\pm j\frac{\sqrt{13}}{2}$

Q2) For the following diagram, which statement is correct.



a)Z(t) = a(t)+b(t)-c(t)+d(t),
b) Z(t) = a(t)+b(t)+c(t)+d(t),
c) Z(t) = -(a(t)+c(t))+(b(t)+d(t)),
d) z(t) = -a(t)-b(t)-c(t)+d(t)

Q3) What are the time constants of the following transfer functions?

$G_1(s)=\frac{2}{0.5s+1}$, $G_2(s)=\frac{6}{3s+2}$

a) 0.5,1.5 , b) 0.5,3 , c) 4,2 , d) 0.5,2

Q4) $G_1(s), G_2(s)$ **and** $G_3(s)$ **have the same gain, but time constants of 3,4 and 5 seconds respectively. Which responds more quickly to a step input?**

a) They all respond the same since the gain is the same
b) $G_1(s)$
c) $G_2(s)$
d) $G_3(s)$

Q5) What are the gain and natural frequency of the following system transfer function?

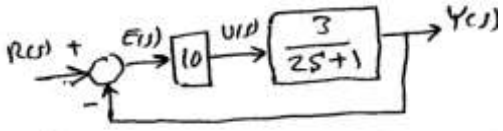
$G(s)=\frac{36}{s^2+3s+36}$

a) 36,6 b) 6,6 c) 1,6 d) 6,1

Q6) The forward, feedback and closed loop transfer function for the system are:

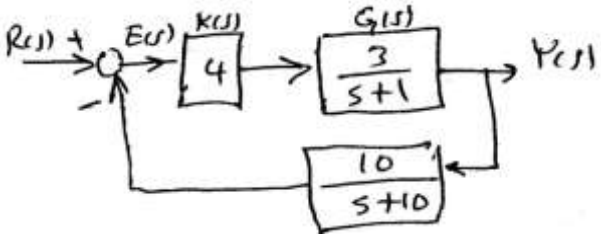
a) $\frac{3}{3s+1}$**, 0,** $\frac{30}{2s+31}$ **b)** $\frac{30}{2s+1}$**, 1,**

c) $\frac{30}{2s+1}$**, 1,** $\frac{30}{2s+31}$ **d)** $\frac{30}{2s+1}$**, 0,**



Q7) What is the characteristic equation of this system

a) $s^2+11s+10$
b) $s^2+11s+130$
c) $s^2+10s+120$
d) $s^2+10s+12$



Q8) If $E(s)=\frac{6}{s^2+3s+4}R(s)$ **what is** e_{ss} **if the input signal is a step input of magnitude 2?**

a) 3 b) 6 c) 1.5 d) 2

Q9) The percentage overshoot of a second order system to a step input depends only on:

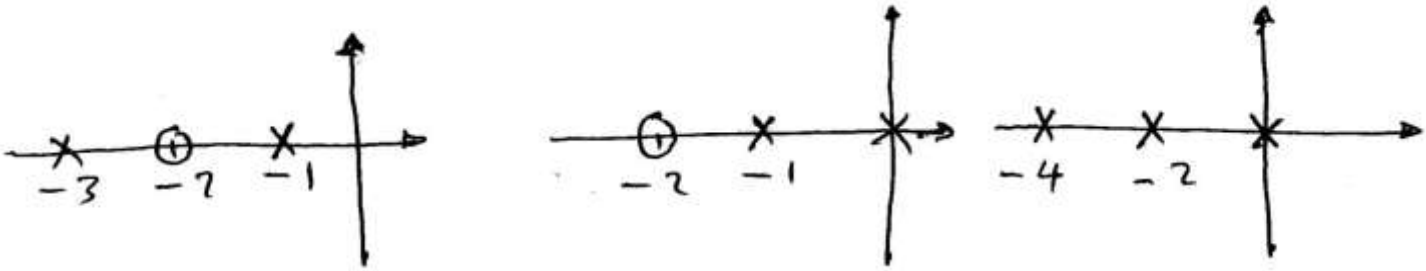
a)The value of the step input
b)The value of the damping ratio
c)The value of the gain k
d)The parameter ω_n

Q10) What are the pole (p) and zero (z) of the transfer function

$$G(s) = \frac{s+2}{s+3}$$

a) p=2, z=3 b)p=3, z=2 c)p=-2, z=-3 d)p=-3, z=-2

Q11) Draw the root locus plot and write the characteristic equations for the following systems:



Q12) What are the advantages of Routh's stability criterion?

Q13) Draw the specification of transient response showing the t_r, t_s, t_p **,p.o.s and** e_{ss} **.**

Q14) Explain by drawing and write the formula for the gain margin and phase margin for type one system third order differential equation.

University of Baghdad
College of Engr.
Mech. Engr. Dept.

Manuf. & Indus. Engr.

M. Sc. Entrance Exam.

Time: 3 hrs.

Part A: Manufacturing Processes (34 M)

1-Which of the following processes is performed in P/M to promote self –lubricating
a-infiltration b-impregnation c-plating d-graphitization

2-The normal range of thickness for sheet metal is:
a- 4 to 8 mm b- 3 to 5 mm c-0.4 to 6 mm d- 0.4 to 1 mm

3-Consider the following parameters:
a-surface finish b- tool life c-Force and power requirements
" Machinability " is defined in terms which of the above?

4- The main purpose of boring operation as compared to drilling is to ----------the hole.

5-Feed in milling is expressed in
a-mm/stroke b-mm/rev. c-mm/tooth d-all of the above

6- During turning of a rod, the following are used:
Feed rate=0.4mm/rev, depth of cut=5 mm, cutting speed=5m/min. The metal removal rate is:
a- 10mm ^{3}/min, b-10000 mm ^{3}/min. , c- 1000mm ^{3}/min. d- 50 mm ^{3}/ min.

7- Most commonly used materials cast by cold chamber die casting include:
a- Al b- Magnesium c-copper d- All of the above

8- Investment casting is most suitable for:
a- Very small sized objects b- medium sized objects
c- Very large sized objects d- medium and large sized objects

9- The material which can be best cut with oxygen cutting process is:
a- Mild steel b- brass c- copper d- aluminum

10- The instrument used to measure external and internal diameter of shafts, thickness of parts and depth of holes is:
a- Micrometer b- depth gauge micrometer c- vernier

11-When the dimension is expressed as $20_{-0.025}^{+0.035}$, and then the tolerance is:
a- 0.035mm b- 0.025mm c- 0.01mm d- 0.06mm

12- In order to check the clearance between two mating surfaces, a----------gauge should be used.
a-ring b- plug c- feeler

13- Which of the following materials has the greatest hot hardens?
a- Plain carbon steel b-high speed steel c-cemented carbides d-ceramics

14-Consider the following processes:
a-blending b-Atomization c-sintering d-comminuting
Which of the above processes is used for producing metal powder?

15-Why is aluminum and magnesium alloys not usually cast by centrifugal casting?

16- Why is it difficult to weld aluminum?

17- In casting, mold shift occurs due to ----------.

18- Why does misrun occur?

19-what important property is an achieved by forging which is not obtainable by other process?

20-For mild steel, the hot forging temperature range is:

a) 400 to 600 ^{o}c b) 700 to 900 ^{o}c c)1000 to 1200 ^{o}c d)1300 to 1500 ^{o}c

21) Extrusion force does not depend upon:

a-extrusion ratio b-type of extrusion process c-material of the die d-working temp.

22-Sintering temperature is approximately equal to ----------of melting point.

a) 25% b)50% c)75% d) 100%

23-In Taylor's equation ($T V^{n}=c$) ,the percentage increase in tool life if cutting speed is reduced by 15% is:(taking n=0.3&c=350).

a)10% b) 15% c) 5%

24-The time required to turn a brass component 50 mm diameter, 100 mm long, 36 m/min cutting speed and the feed is 0.4 mm/rev. is :

a) 65 sec. b) 65 min. c) 130 sec.

25-The power consumed during cutting of a low carbon steel bar 40mm diameter if cutting force is 1500 N at 200 r.p.m is :

a) 6280 W b) 628 W c)314 W

Part B: Industrial Engineering (34 M)

Answer *ALL* the following questions by (Yes) or (No):

1. **Quality control is used to measure the productivity of the company.**
2. **The production planning and control function is considered as the major function of the company?**
3. **Outside inspectors are used in controlling the bought-out materials from manufacturers.**
4. **Forecasting is the 1st step of the planning function?**
5. **The number of defects found in a manufactured batch represents customer risk.**
6. **The type of product used limits economic batch quantity?**
7. **The cost of repairing sold products is included in the cost of the manufacturing.**
8. **OC curve is a representation of the number of defected part in a manufactured batch of production.**
9. **The capacity of the factory is determined by the capacities of machines used only?**
10. **Statistical analysis is an important factor in deciding whether to use quality control charts.**
11. **The type of layout used in a factory is chosen in accordance to the quantities to be produced from the products?**
12. **Sampling plans are used when the quantities to be inspected are large.**
13. **The economic batch quantity can be reduced by use of alternative methods of production?**

14. **There must always be enough space for the movement of the worker and machines to be operated, on the floor of the factory?**
15. **Machines must be set before starting the inspection of produced parts.**
16. **The number of operations for a product will determine the size of the plant?**
17. **It is always possible to use measuring devices in the measurements of tolerances of operations.**
18. **The use of activity chart will determine the sequence of operations for a product?**
19. **Quality control charts will always define the tolerances of the parts.**
20. **There is no limitation on price increase when reducing the economic batch quantity?**
21. **In control charts, when the lower bound is negative, it must be set equal to zero.**
22. **The process used for the manufacturing of the parts limits material utilization?**
23. **Double sampling plan is used when the tolerances are high.**
24. **Mass production is not considered as a flexible manufacturing system?**
25. **The number of defected parts in an operation is affected by the accuracy of the machine used.**
26. **A non-promising activity can be made profitable by reducing its consumption of the limited resources?**
27. **In control charts, the batch size must be constant over all stages of production.**
28. **The bottlenecked machine controls the maximum output of a line?**
29. **The number of finished parts returned from customers as defects measures quality.**
30. **The size of the batch is affected by the changes made in the tools?**

Part C: Metallurgy & Engineering Materials (34 M)

CIRCLE THE RIGHT ANSWERS

Q1: The most ductile metals have crystal structure:
A – BCC B – FCC C – HCP

Q2: For good strength, metals should have:
A- Large grain size B – Small grain size C – Has no effect

Q3: Normalizing is used to:
A – Improve strength B – Refine the structure C – Both A & B

Q4: Tempering of hardened carbon steel is used to.
A – Increase toughness B –Remove residual stresses
C – Reduce hardness D – All of these

Q5:The minimum amount of Chromium in stainless Steel is :
A – 7 % B – 10% C – 13 %

Q6: The hardness of martensite mainly depends on,
A – Carbon content B – Alloy elements content C – Both A&B

Q7: Bainite structure combines between,
A – High hardness & low ductility B - High ductility & high strength
C – Low hardness & high ductility

Q8: Which of these alloys are best for damping vibration,
A – White cast iron B - Grey cast iron C – Low carbon steel

Q9: For high ductility which brass you choose,

A – 6o%Cu / 40%Zn **B – 30%Cu / 70%Zn** **C – Both A & B**

Q10: Martensite combines between,

A – High hardness & low toughness **B - High hardness &high toughness**

C - High hardness &low ductility

Q11: Recrystallization is aimed to,

A – Regain ductility **B – Increase hardness** **C – Both A & B**

Q 12 - Which of the following is the purpose of heat treatment

A – Improve ductility **B – Improve strength & hardness**

C – Eliminate the effect of cold working

Q13: List five main applications in which Aluminum is widely used.

Q14: List the main types of polymers and give example for each type.

Q15: What are Composites and way they are made.