**Lecture Twelve**

**Balancing of rotating masses**

In this chapter we shall discuss the balancing of unbalanced forces caused by rotating masses, in order to minimize the loads on bearings and stresses in the various members, which causes dangerous vibrations when a machine is running.

The following cases are important from the subject point of view:

**1.** Balancing of a single rotating mass by a single mass rotating in the same plane.

**2.** Balancing of a single rotating mass by two masses rotating in different planes.

**3.** Balancing of different masses rotating in the same plane.

**4.** Balancing of different masses rotating in different planes.

**1. Balancing of a Single Rotating Mass By a Single Mass Rotating in the Same Plane**

Consider a disturbing mass *m*1 attached to a shaft rotating at ω rad/s as shown in

Fig .1. Let *r*1 be the radius of rotation of the mass *m*1. We know that the centrifugal

force exerted by the mass *m*1 on the shaft,

*F*Cl = *m*1. ω2. *r*1 …………….(1)



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**Fig. 1.** Balancing of a single rotating mass by a single mass rotating in the same plane.

This centrifugal force produces bending moment on the shaft. In order to counteract the effect of this force, a balancing mass (*m*2) may be attached in the same plane of rotation as that of disturbing mass (*m*1) such that the centrifugal forces due to the two masses are equal and opposite.

Let *r*2 = Radius of rotation of the balancing mass *m*2, centrifugal force due to mass *m*2,

*F*C2 = *m*2. ω2. *r*2 …………….(2)

Equating equations (1) and (2),

*m*1. ω2. *r*1 = *m*2. ω2. *r*2 or *m*1. *r*1 = *m*2. *r*2

**2. Balancing of a Single Rotating Mass By Two Masses Rotating in Different Planes**

In order to put the system in complete balance, two balancing masses are placed in

two different planes, parallel to the plane of rotation of the disturbing mass, There

are two possibilities may arise while attaching the two balancing masses:

**a) When the plane of the disturbing mass lies in between the planes of**

**the two balancing masses**

Consider a disturbing mass *m* balanced by two rotating masses *m*1 and *m*2 as shown in Fig. 2. Let *r*, *r*1 and *r*2 be the radii of rotation of the masses *m*, *m*1 and *m*2 respectively.



**Fig .2.** Balancing of a single rotating mass by two rotating masses in different planes when the plane of single rotating mass lies in between the planes of two balancing masses.

The net force acting on the shaft must be equal to zero

*F*C = *F*Cl + *F*C2

*F*C : Centrifugal force exerted by the mass *m*

*F*C1 : Centrifugal force exerted by the mass *m*1

*F*C2 : Centrifugal force exerted by the mass *m*2

*m*. ω2. *r* = *m*1. ω2. *r*1 + *m*2. ω2. *r*2

*m*. *r* = *m*1. *r*1 + *m*2. *r*2

Now in order to find the magnitude of balancing force at the bearing *B* of a

shaft, take moments about *A*. Therefore

*F*C1 × *l* = *F*C × *l*2 or *m*1. ω2. *r*1 × *l* = *m*. ω2. *r* × *l*2

*m*1. *r*1 × *l* = *m*. *r* × *l*2

Similarly, in order to find the balancing force at the bearing *A* of a shaft, take

moments about *B*. Therefore

*F*C2 × *l* = *F*C × *l*1 or *m*2. ω2. *r*2 × *l* = *m*. ω2. *r* × *l*1

*m*2. *r*2 × *l* = *m*. *r* × *l*1

**b) When the plane of the disturbing mass lies on one end of the planes of the balancing masses**

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**Fig .3.** Balancing of a single rotating mass by two rotating masses in different planes, when the plane of single rotating mass lies at one end of the planes of balancing masses.

This case shown in Fig .3. As discussed above, the following conditions must be

satisfied in order to balance the system, *i.e*.

*F*C + *F*C2 = *F*Cl or *m*. ω2. *r* + *m*2. ω2. *r*2 = *m*1. ω2. *r*1

*m*. *r* + *m*2. *r*2 = *m*1. *r*1

Now in order to find the magnitude of balancing force at the bearing *B* of a shaft, take moments about *A*. Therefore

*F*C1 × *l* = *F*C × *l*2 or *m*1. ω2. *r*1 × *l* = *m*. ω2. *r* × *l*2

*m*1. *r*1 × *l* = *m*. *r* × *l*2

Similarly, to find the balancing force at the bearing *A* of a shaft, take moments about *B*. Therefore

*F*C2 × *l* = *F*C × *l*1 or *m*2. ω2. *r*2 × *l* = *m*. ω2. *r* × *l*1

**** *m*2. *r*2 × *l* = *m*. *r* × *l*1